CONTAMINATION OF GROUND WATER BY PESTICIDES

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BEFORE THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

OF THE

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
HOUSE OF REPRESENTATIVES

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CONTAMINATION OF GROUND WATER BY PESTICIDES

THURSDAY, AUGUST 11, 1988

House of Representatives,
Subcommittee on Investigations and Oversight,
Committee on Public Works and Transportation,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:20 a.m., in room 2167, Rayburn House Office Building, Hon. James L. Oberstar (chairman of the subcommittee) presiding.

Mr. Oberstar. The Subcommittee on Investigations and Oversight will come to order.

This morning the Subcommittee continues its hearings on ground water contamination. We have held hearings in the past on contamination by hazardous wastes and by synthetic organics. Today we turn our attention to another, possibly equally pervasive, threat to our water resources.

Ground water supplies are responsible for drinking water for nearly 50 percent of all Americans, and in rural America, ground water represents the source of drinking water for 97 percent. It provides irrigation water for crops, recharge for surface streams, and it sustains aquatic wetlands and terrestrial ecosystems. In coastal areas it helps prevent salt water intrusion into drinking water supplies. It provides a hydrostatic pressure to provide against salt water seeping into the ground areas. A graphic example of the significance of surface water as a barrier against salt water is the lower Mississippi, where as a result of the drought, the Mississippi is literally flowing upstream with salt water intrusion.

Ground water is an irreplaceable component of our total water supply. Our food supply, vital to life, is threatened by some 2,000 species of weeds, 1,000 species of nematodes, and 10,000 species of insects, most of which live in my back yard, to say nothing of rodents, fungi, and other pests with which our farmers are forced to contend. To protect that food supply, farmers apply some 820 million pounds of active pesticide ingredients to fields and crops, out of the nearly 1 billion pounds of active ingredients this nation uses every year.

Even after Rachel Carson's dramatic "Silent Spring," in 1962, most Americans continued to believe that our ground water, at least, was safe from pesticides. That confidence was shattered in 1979 with discoveries of massive contamination and well closings caused by DBCP in California's Central Valley and Temik on Long

Island in New York. Since then, we have found more pesticides in more locations around the country.

Once in the resource, in the ground and in the ground water it is permanent. Removal at the surface is expensive. California has spent over $10 million in the Fresno area alone on alternatives to DBCP contaminated water.

Manufacturers of Temik, which contaminated Long Island's aquifers, are paying for treatment for six large-capacity public supply wells, and 3,000 individual treatment systems. There is $350,000 per year being spent in monitoring costs in that same area.

Florida's legislature appropriates $3 million per year for EDB-free water supplies. Iowa found that conventional treatment systems are unable to eliminate, or even significantly reduce, concentrations of pesticides in its ground water. Most ground water contamination discovered so far has been at relatively low levels. The absence of massive contamination across the country is not a sign that there is no problem, and it does not guarantee that the 53 million Americans who drink potentially contaminated water will escape chronic health problems. Prudent public policy dictates that we pay attention to the warning signs, that we take action now while we still may be able to prevent further endangerment of our water resources, and that we do so through sound science and through uncompromising health and environmental standards. Preventive action is far less costly, far wiser, far more protective, than remedial action, as we have seen in case after case throughout this country.

At the same time we must continue to recognize the unique problem that America's farmers face. They are on the front line in the war against pests. They have the wells that may be the first casualties in this pesticide war. Better than anyone else, they know the problem. They are looking for wiser and more sparing ways to use safer pesticides, as are the chemical industries that are involved in providing the ammunition in the war against pests.

And there, of course, is the rub—is our choice nematodes or Temik-free water? Atrazine or starvation? Are kiwis compatible with the environment? Existing law and proposed legislation wrestle with this problem, although it is unclear whether any new legislation will be approved in the remaining days of the 100th Congress.

Fortunately, we in Congress are not alone in this effort. The Environmental Protection Agency has already proposed its Agricultural Chemicals In Ground Water Strategy. The Department of Agriculture's Economic Research Service has drawn up a masterful projection of the potential problem. EPA's well-water survey will help develop the basic data we need to make projections, and to consider appropriate kinds of action. States are responding on their own, doing more detailed surveys to flesh out our understanding of the problem and providing their own approaches to the various problems along with their own recommended solutions. Farmers and farm organizations, as well as public and private interest groups, are devoting experience, ingenuity, financial resources, time and effort to the quest.

How to strike the balance between regulatory and voluntary actions, how to meet stringent health standards while protecting our food supply and our farmers' livelihood: that is the subject of today's hearing. This hearing is prospective, rather than reactive. Unlike other hearings of this subcommittee where we are looking into malfeasance, misfeasance, or nonfeasance of Federal Agencies, we are looking at this issue to determine its dimensions, and its potential for a problem in the future.

Some may argue that there is no problem and others, that we face another ecocalamity. Are the pesticide findings, so far, the tip of a plume resulting from 30 or more years of pesticide application? Have we already caught the culprit pesticides, and replaced them with safe, and biodegradable ones? Or are we, for once, discovering a problem just in time? That is the subject of today's hearing, and our witnesses will lend wisdom, statistical data, and insight to our quest for information, knowledge, and solutions.

The Chair recognizes the gentleman from Minnesota, Mr. Stangeland. He represents a significant agricultural area of the State and has been deeply involved in these issues for many years. Mr. Stangeland.

Mr. STANGELAND. Thank you, Mr. Chairman. I appreciate the opportunity to join you and the other members of the committee for the hearing today and I ask unanimous consent that a statement by the Honorable William Clinger, the ranking Republican on this subcommittee, be placed in the record at this point.

Mr. OBERSTAR. Without objection, so ordered.

[Mr. Clingers's prepared statement follows:]

STATEMENT OF HON. WILLIAM F. CLINGER, JR. (R-PA)

Thank you, Mr. Chairman, and welcome to the witnesses who will be appearing before the Subcommittee today to share with us their knowledge regarding the problem of contamination of ground water by pesticides.

Mr. Chairman, ground water may be among the most precious, but least understood, of our natural resources. Despite its importance, the difficulty and expense of measuring groundwater's precise location, movement, quantity and quality have resulted in our not knowing as much about groundwater as rational planning, conservation and the public health would seem to dictate that we should.

We do know that groundwater furnishes approximately one-half of our drinking water needs, overall, and an overwhelming proportion of rural domestic needs; we know that groundwater provides the base flow for many of our surface waters, emphasizing once again the relationship and interdependence of surface and groundwater quantity and quality. We also know that groundwater has, in some locations, become contaminated by pesticides and that cleanup is extremely difficult and expensive, if not impossible.

Beyond some of those basic parameters, however, the things we know and can agree on dwindle in number very rapidly. For example, we lack any kind of consensus on the extent of contamination, the severity of contamination, and the steps necessary to contain or prevent future groundwater pollution. In some cases, this lack of consensus is the result of incomplete or conflicting data; in others, well-meaning experts simply disagree.

While common sense says that we should do everything we can to prevent pesticide contamination of our groundwater resources, the nation's need for food and fiber, whose production is measurably bolstered by the application of insecticides and herbicides, is an offsetting consideration which must be factored in. As long as pesticides continue to be manufactured, transported and applied, either commercially or in agriculture, some pollution will inevitably occur—through spills, application onto sensitive groundwater recharge areas, and other leaching into subsurface groundwater aquifers.

Is there some acceptable level of contamination? What are the attendant risks? Our increasing ability to detect ever smaller and smaller levels of contaminants—

and the unknowns of associating exposure levels with acute and chronic long-term health effects—create uncertainty. While we may never resolve all the uncertainties, I would hope that today's hearing will better inform the Subcommittee of the nature and extent of pesticides in groundwater and offer guidance as we continue to address the issue.

I look forward to a productive day's session, Mr. Chairman, and thank you for having the foresight and concern to bring this important issue before the Subcommittee.

Mr. STANGELAND. Like you, Mr. Chairman, I have a strong interest in protecting the Nation's ground water. Our state of Minnesota places a high priority on saving this "unseen resource," and they have every reason to. About two out of every three Minnesotans use it as a source of drinking water. In most rural areas, this rate of usage increases to over 95 percent of the population.

I have a strong interest in protecting ground water for another reason. I am a farmer and I depend on the land and the water that runs above and below the land. In preventing ground water contamination, few have more at stake than the American farmer. He or she depends on it for crop production as well as water supply. At the same time, improper use of agricultural chemicals, such as pesticides and fertilizers, can or may contribute to the problem.

I recognize this and I know, Mr. Chairman, that you do as well. Last year with your help, this committee held extensive hearings on and then marked up a comprehensive ground water research bill, H.R. 791. This legislation greatly increased the roles of the EPA and the United States Geological Service in providing research, technical assistance, and cleanup demonstrations.

At the same time, the Agriculture Committee worked extensively on its contribution to the ground water research bill. The Agricultural Ground Water Management Act of 1987 requires the Secretary to study and report on agricultural practices and water quality. This would certainly contemplate pesticides in ground water. The provisions also include my bill that would establish a task force to develop best management practices for fertilizers. As you know, this bill passed the House overwhelmingly last December. However, the Senate is still considering its comparable ground water research bill.

In the meantime, we are seeing a flurry of activity on FIFRA and ground water. Both the House and Senate bills have ground water protection provisions in them. I believe that, coupled with the House's ground water research bill, the House's FIFRA reauthorization bill offers a good approach to pesticides in ground water. It provides some real protection while steering clear of major policy or implementation problems raised in other proposals.

Some say that we should pass another major Federal environmental statute that regulates ground water just as the Clean Water Act regulates surface water, and that we should provide a complete overhaul to the FIFRA ground water programs. I think this approach is premature, given today's lack of knowledge about the resource and its sources of contamination. I do not believe we should rush to impose costly, far-reaching regulations on everyone from farmers to chemical manufacturers. Instead, I think we need to learn more about the problem and its solutions. I hope, Mr. Chairman, hearings such as the one you are holding here today will go a long way in providing us with that knowledge.

Fortunately, the consensus emerging in Congress is to focus on the Federal role in research, technical assistance, and fine tuning of existing regulatory mechanisms. This recognizes fiscal and political realities and the primary role that States have in managing ground water resources. It avoids the pitfalls of mandating new Washington-based standards that intrude on State and local use decisions and farming practices. At the same time, I believe that it gives industry incentives to improve research and development activities, best management practices, training of certified applicators, and labeling techniques.

I know, Mr. Chairman, that you have a sincere interest in protecting Minnesota's and the Nation's ground water resources while not unduly interfering with State and local sovereignty or agricultural operations. Today's hearing should be very helpful, and I look forward to analyzing the testimony from our distinguished witnesses.

I thank you very kindly for allowing me to participate in your hearing.

Mr. OBERSTAR. I thank the gentleman for those remarks and the very insightful observations on the dimension of the problem that we face and the approach of this particular hearing.

We have a recorded vote in progress on the House floor, so I would like to swear in the witnesses and recess for this vote. We will return to take the testimony.

[Witnesses sworn.]

The subcommittee will stand in recess pending this vote.

[Recess.]

Mr. OBERSTAR. The subcommittee will resume its sitting.

Our first witness is Ms. Susan Wayland, Deputy Director, Office of Pesticide Programs of the U.S. Environmental Protection Agency. Our next witness, Mr. John Miranowski, is the Director of the Natural Resource Economics Division, the Economic Research Service of the U.S. Department of Agriculture. Also, we have Mr. Robert Barles, Director of Ground Water Policy Staff for EPA.

Ms. Wayland, would you like to begin?

TESTIMONY OF SUSAN WAYLAND, DEPUTY DIRECTOR, OFFICE OF PESTICIDE PROGRAMS, U.S. ENVIRONMENTAL PROTECTION AGENCY, ACCOMPANIED BY ROBERT BARLES, DIRECTOR, GROUND WATER POLICY STAFF, EPA, AND JOHN MIRANOWSKI, DIRECTOR, RESOURCES AND TECHNOLOGY DIVISION, ECONOMIC RESEARCH SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Ms. WAYLAND. Thank you very much, Mr. Chairman. Good morning to you and the other members of the Subcommittee.

We appreciate very much the opportunity to come up this morning and talk about the issue of pesticides in ground water, because it is obviously one of very high priority in the Environmental Protection Agency. I would like to submit my prepared statement for the record, but use my time to talk about some of the highlights from that statement.

Mr. OBERSTAR. Your statement will be included in the record in full. You may summarize as you wish.

Ms. WAYLAND. Thank you.

I think that there are really two simple, fundamental, questions to pose that are very difficult to answer about pesticides in ground water. Those are, what is the extent of the problem, and what are we going to do about it? To answer the first question, which you alluded to in your opening statement, Mr. Chairman, we have underway a national survey of pesticides in drinking water wells that my Office and the Office of Drinking Water are cooperatively sponsoring. There are two primary objectives to that survey. One is to characterize the extent of pesticide contamination in drinking water wells across the country, both the private wells and the community systems. The other is to determine, to the extent possible, the relationship of the occurrence of pesticides in wells and the use and local characteristics of the wells in which those pesticides have been found. This is the first nationwide survey that has been conducted on pesticides in ground water. We are looking for about 60 priority pesticides across the country. As a result of this survey, we hope to get the national picture of the extent of the problem.

We conducted a pilot last year for the survey, and we had three States participating: Minnesota, Mississippi, and California—and I say this very sincerely and not gratuitously, Mr. Chairman, because of where you are from—but we have had excellent cooperation from the State of Minnesota, and we have learned a lot from the State and have received a great deal of good advice and help in conducting our survey, for which we are very appreciative.

The full survey began this Spring. We are going to be sampling in 1988 and 1989 throughout the country, with a report to be completed in 1990. I think that the survey has already been valuable in a couple of ways. There have been some spinoffs of the survey that we think have been valuable. One is that we have developed some 62 health advisories for pesticides that may be found in drinking water. We pledged to ourselves, to the States, and to the public, that we really would not begin looking for pesticides in drinking water until we had an idea how to assess those findings and their significance on public health.

The second byproduct of the survey is the development of six new multiresidue methods which will help us analyze for pesticides in drinking water. Those methods have been distributed, of course, not only to our contractors who are helping us with the survey, but also to State laboratories and other laboratories that are doing work in this area.

We also think that communication is extremely important in this survey. Communication is really just as important as the technical aspects of the survey, and we have been working very hard with State departments of agriculture, water supply, and public health, in order to discuss with them the purposes of our survey, why we are coming to the State, and to provide the cooperation that we are going to need from well owners. So far, we have had excellent cooperation from the States and from well owners throughout the country in the areas where we have been.

On the issue of what we are going to do about pesticides in ground water, we have a proposed strategy, which has been published for comment. This strategy, which was developed over a two-year period, is a result of a lot of discussions and a lot of involvement from the public in helping us think through these issues. We have had two national workshops in the last two summers, in which we have invited a lot of folks from various State agencies, from the Department of Agriculture, from USGS, from environmental groups and farmers, and from the pesticide producing industry, to sit with us and help us think through some of these tough issues. What has evolved from that dialogue is a clear need to articulate a framework which would give structure to dealing with this problem, but one that is flexible enough to permit different approaches for different State and local soils and climate, hydrogeological conditions, and agricultural practices. We have tried to achieve that balance in our proposed strategy.

There are three points I would like to make about the strategy this morning. One is that we have stated a goal in the strategy, and that goal is to manage the use of pesticides which may leach into ground water. We are using drinking water standards and MCLs as reference points in order to help us achieve those goals. We have a risk/benefit statute that we administer under FIFRA and so we can not say up front what the absolute standards that we are going to be using are for any particular chemical in any particular context, but what we have said in the strategy is that we are making a presumption that if pesticides are found in current or potential drinking water at levels that exceed the standards established under the Safe Drinking Water Act, that we are going to presume that the risks in those cases will exceed the benefits.

The second thing that I would like to point out is that this strategy emphasizes prevention. I would like to echo one of your opening remarks, Mr. Chairman, which is that contamination, once it has occurred, is very hard to clean up, if not impossible to clean up, particularly when we are talking about the nonpoint source contamination of the pesticides through normal agricultural use. It is important to stop the problem before it has happened, and what we have proposed in the strategy is what we called a "yellow light/red light approach," where we would be taking more and more stringent actions if it appears that findings of pesticides in ground water are exceeding acceptable levels.

The third thing that I would like to emphasize this morning is that we have proposed a Federal/State role in this strategy that talks about a division of labor which is very different than a lot of pesticide approaches that we have taken in the past. We really do believe that when the risk is so closely linked to local variability, then the risk management approaches should be determined as close to the source as possible. Therefore, we have proposed in the strategy that for some pesticides, the Federal registration of those chemicals will be contingent on a State developing a management plan to specify the conditions of use or, in some cases, no use in vulnerable areas.

What we are really talking about here is a different way of approaching the regulation and management of pesticides from our traditional approach of regulating at the national level. In many cases, we are speaking here about creating new institutional links among State agencies as well as Federal agencies, and new skills are going to have to be brought to bear if we are going to go forward and implement the strategy as we have proposed it. We are marching toward a final strategy and we hope to have the final document by the end of the calendar year, and as in development of the strategy, we want to continue the public dialogue on what we are doing. For example, this fall, we are going to be holding a series of workshops around the country to talk specifically about what is a State management plan, what are the critical elements of a State management plan, how we are going to assess the effectiveness of the State management plans, and although we put a lot of emphasis here on prevention, we want to address what is going to happen in cases of contamination also, in order to protect public health in specific situations.

I have talked a lot about the State role, and I think it is very important to do that, but the Federal role here is also very important. We are doing several things that I would like to highlight very briefly this morning. One is that we are looking very closely at new chemicals when they come on the market for registration. We are requiring complete databases on environmental fate for those chemicals so we can assess their potential to leach into ground water.

Second, we are looking at all the old chemicals through our registration program and we are putting those chemicals through a special intensive public process known as "Special Review," if we believe that the risks may pose unacceptable contamination in ground water. A case in point is the pesticide aldicarb, which has been in that process and for which we have recently issued a proposed decision. This is the first chemical to which we have applied our new strategy.

The third thing we are doing is talking about restricting the use of some pesticides because of ground water concern only to certified applicators. We have a rule that is being developed within the Agency that we hope will be out for public review in several months. The other side of that coin is applicator training and certification. We restrict pesticides and we have to have applicators who are trained and certified and who know what we are talking about when we say that this is a ground water problem. We have just developed, with the Department of Agriculture and their contractors, a new training module for ground water protection from pesticides, which has just been released and is going out to the States and the Extension Services. We hope that this manual will be used in training sessions across the country this winter.

We are also imposing monitoring requirements on pesticide registrants from the Federal level. We are asking in the case of new chemicals, for some prospective studies, and in the case of some older pesticides, retrospective studies where we ask registrants to go back and look at which chemicals have been heavily used and the impact on the ground water of those chemicals. Obviously, one of the Federal roles is when the risks are too great or where they can not be managed at reasonable levels, put those pesticides into the cancellation process for some or all of their uses. Another Federal role is to continue modeling research and development to better predict which pesticides will find their way to ground water, and hopefully for the future, what amounts of pesticides may be found in ground water.

Another effort is doing across-the-board label changes from my program on national labels where local variability is not really a factor, such as practices where pesticides are introduced as part of an irrigation system. As was mentioned, another Federal role is to establish standards, the MCLS, and health advisories under the Safe Drinking Water Act, and finally, to establish an information transfer and coordination system. We need to do a better job at bringing together the activities that are going on under the water acts, as well as the activities that the Department of Agriculture has underway now, in order to make them part of our strategy for protecting ground water from pesticides. That would include nonpoint source programs under the Clean Water Act, ground water planning activities which have been going on now for several years under the Clean Water Act, the new well protection activities that a lot of States are engaged in right now, as well as IPM development and management practices which are being researched by the Department of Agriculture. All those things really need to fit into the strategy that we are now proposing so that they all make a holistic approach to protecting this resource.

That basically concludes my highlights. I will be happy to answer your questions.

Mr. **Oberstar**. Thank you very much for a very thoughtfully delivered and obviously well thought through presentation. We appreciate your contribution and will have some questions in a moment.

Mr. Miranowski, we would like to hear your statement next.

Mr. **Miranowski**. Thank you, Mr. Chairman. We appreciate the opportunity to be here to discuss with the subcommittee the preliminary findings on the relationship between agricultural pesticide use and ground water quality.

There has been a growing concern among farmers, the public, and government officials about the possible presence of pesticide residues in ground water, as reflected in several statements this morning. Potentially harmful concentrations of pesticides in ground water have been found in selected samples from a number of States. However, statistics relating agricultural activities and ground water contamination are incomplete. This has hampered the process of identifying the magnitude and nature of the problems and developing a response to the issues.

There is no national database on the actual levels of agricultural chemicals in ground water, and current analysis is restricted to the conditions that define the possibilities for contamination, as opposed to actual contamination. In a recent USDA study, "The Magnitude and Costs of Ground Water Contamination From Agricultural Chemicals," an attempt was made to use available data from a number of sources to identify areas with a potential for pesticides to leach into ground water. This study also developed a general measure of the costs of monitoring private wells for pesticide residues.

To measure the extent of the potential for contamination of ground water by pesticides, two factors were considered: the vulnerability of ground water to materials leaching through soils, in other words the geophysical type of environment there, and the application rates of pesticides to cropland. The vulnerability of ground water to leaching chemicals was measured by the DRASTIC score. The DRASTIC score is a measure developed by the Environmental Protection Agency. It synthesizes seven hydrogeologic factors into a single index, which indicates the potential for chemicals to leach into ground water. A DRASTIC score was calculated for each of the 3,100 counties in the 48 contiguous States. A high value of this index indicates that the county has a greater potential for pesticides to leach into ground water as chemicals are applied to the overlying cropland. Application rates for pesticides which have a tendency to leach to ground water were obtained from USDA and other data sources. Each county in the 48 States was classified as either high, medium, or low, in terms of application levels of those pesticides. I might indicate here also that the pesticides that we used essentially dealt with 38 chemicals out of the 45 that EPA had identified as highly leachable.

The data on pesticide applications and the DRASTIC scores were then combined to get a general indication of the potential for ground water contamination on either the basis of a high DRASTIC score, a high application rate, or a combination of both. In terms of those that fell into the category that we identified as potential counties, out of the 3,100, there were about 1,100 counties. Of those, 361 had both a high DRASTIC score and a high application rate as defined in the study.

Ground water resources in areas with potential for contamination provide drinking water to a substantial population, particularly in rural areas, as has already been pointed out. Since the economic costs of human exposure to these chemicals in drinking water is very difficult to quantify, we used an alternative approach to measure the costs associated with avoiding human consumption of contaminated drinking water. Basically, we define the cost as the expenditures necessary to monitor and detect the presence of pesticides in private wells. The cost of such a program, to monitor these wells on a one-time basis, ranged somewhere between $900 million and $2.2 billion. The one thing that I might point out here is that we looked at this as sort of a one-time monitoring effort, and we also assumed that we were going to monitor all the private wells with current technology. It is very likely that one would not have to monitor all of the wells as better technology comes about, but this estimate does not include the expenditures to acquire water from alternative sources or to treat potentially contaminated ground water and drinking water.

The statistics presented in the report need to be qualified a bit here. That is, they only serve as broad regional and national indicators of the nature of the problem. There are some implications that can be drawn from these preliminary results, and I would like to highlight a couple of these. First, although affecting primarily farming and rural areas, over 40 million people live in areas identified as having potential for ground water contamination from pesticides, which is a significant portion of the population.

Second, the potential for ground water contamination is not national in scope. Areas of potential contamination appear to be regional, often extending beyond the local and State jurisdiction, though. The results of the study should be viewed with some caution. The most important part is to distinguish between the concept of potential for versus actual evidence of pesticides leaching into ground water. This study only dealt with the potential for and not the actual leaching into ground water. While data identified over 1,100 counties as potentially vulnerable to ground water contamination from pesticides, it cannot be concluded from these results that the wells in these regions are necessarily contaminated with pesticide chemicals. The actual extent of ground water contamination is currently unknown, and that is the basis of the well-water survey in this context.

In addition, the data used to measure ground water vulnerability in pesticide applications are broad aggregate measures that may mask considerable variation at the local level, and that variation may be in pesticide application rates, or it may be variation within the county in terms of the geological type of formations there and the ability of pesticides to leach in that context. Since the available data are based on approximate countywide averages, they do not take into account the subcounty variations, and thus, the comparisons on a county-by-county basis in this context, are questionable and not valid from our perspective.

Further, it cannot be assumed that all pesticides found in ground water come from agricultural activities. Significant quantities of pesticides are used on lawns, golf courses, mosquito abatement, and other nonagricultural purposes, so I do not think we want to attribute all of these chemicals necessarily to agricultural activities. Better data and further research are needed to understand the exact nature, scope, and extent of the potential for pesticides to leach into ground water. The summary USDA report merely sets the stage for further, more detailed economic and physical analyses that are needed to link the relationship between agricultural production activities and unacceptable ground water contamination. Additional evidence will be available in the future as EPA completes its well-water survey. Future economic and policy analyses of strategies to prevent ground water contamination will depend heavily on the availability of and quality of the data, both physical and economic, on ground water contamination, pesticide use patterns, and local variations in ground water variability.

Mr. Chairman, this completes my statement. I would be glad to respond to any questions you might have.

Mr. **Oberstar**. Thank you very much for a very thorough response to the issues that we asked you to address and for your helpful insights into the issues at hand.

The Chair would like to recognize the gentlewoman from Maryland for an opening statement.

Mrs. **Bentley**. Mr. Chairman, I just ask unanimous consent to have a prepared statement included.

Mr. **Oberstar**. Without objection, the statement will be included in the record at this point.

Mrs. **Bentley**. Thank you.

[Mrs. Bentley's statement follows:]

Statement of Hon. Helen Delich Bentley

Thank you, Mister Chairman, and thank you, Mister Clinger, for scheduling this subcommittee hearing today to address an issue that is of growing concern to citizens throughout this country.

The planet on which we live is very fragile and is becoming more polluted with each passing day, jeopardizing its existence for future generations.

Man has done more damage to the environment—the land, the water and the air—during the past century than all of the previous centuries combined.

There has been recognition of our carelessness and a conscious effort continues to be made to clean up the mess we have created, so that future generations may live in a healthy environment.

There are, however, those critics who say that enough is not being done. I join with those critics, because the cleanup efforts and the corrective actions implemented are insufficient.

More effort and, yes, money must be expended if we are to cope with the ever mounting problems of pollution.

This committee and the House Merchant Marine and Fisheries Committee held hearings on proposed legislation setting a timetable for the elimination of sewage sludge in the Atlantic Ocean.

Both committees have recognized the urgent need to stop polluting the oceans.

Cities throughout this country need to dispose sewage sludge, as well as trash, toxic chemicals and other debris that is discarded.

The question arises: Where will we deposit these materials? The answer, in many cases, is at landfills—landfills where the leaching of these materials poses a serious health threat to our drinking water.

The same is apparently true with the use of chemicals and pesticides used in agriculture.

The contamination of ground water is but one of a myriad of environmental problems facing us.

I share the concerns of my colleagues on this subcommittee on this issue, and I look forward to hearing from the witnesses scheduled to testify today on the scope of pesticides polluting our ground water; and I pledge my support in addressing these problems so that we can some day return this planet Earth to the condition God gave it to us—pollution free.

We may never achieve that level of purity. In fact, I am sure that we won't. But, we must try because life on Earth—for man, wildlife, marine life and plants—so dearly depends on our efforts.

Thank you, Mr. Chairman.

Mr. OBERSTAR. Thank you.

Dr. Rowland, the Chair would like to recognize you for an opening statement.

Mr. ROWLAND. Thank you, Mr. Chairman. I have no real opening statement, but I just want to make a comment about my concern about ground water in the rural areas of our country, because I represent a rural area and I am concerned about the farmers and the knowledge that they have about this particular issue and the long-term effects of it. I just want to compliment you on having this hearing.

Mr. OBERSTAR. Thank you very much.

Ms. Wayland, could you elaborate further on the decision of EPA to use the Maximum Contaminant Levels instead of the MCLG's, the Maximum Contaminant Level Goals. I think we better use the "alphabet soup," because by the time you get those words out, the hearing will be concluded. What was the thought process that brought you to that point?

Ms. WAYLAND. Mr. Chairman, obviously one of the primary uses of ground water is for drinking water purposes, and we thought, in developing our strategy, that we really needed to address not only the potential for pesticides to get into ground water, but what might be the resulting exposure of that contamination. Because ground water is such an important source and because our Office of Ground Water Protection already establishes standards under the Safe Drinking Water Act, we though it was a logical place for us to go as our reference point to begin looking at pesticides in ground water.

Obviously there has been a lot of debate between using MCLS versus using MCLG's, and you probably know that MCLS are the regulatory standard that operators of community public systems must comply with. MCLG's are the goals that are established before MCLS are actually put into place. We have looked at MCLG's, and in many cases MCLG's are developed very similarly to the way in which we are developing pesticide residue tolerances for those chemicals used on food. But as you also know, because of policy statements as well as directives from the Safe Drinking Water Act, the MCLG's for chemicals that are carcinogens that have nonthreshold effects are set at zero.

When we looked at MCLS, there were a couple of reasons why we went with MCLS versus MCLG's. One was that MCLS are the regulatory standard that drinking water suppliers must adhere to in this country. We thought that if we introduced different numbers, it would be confusing to both drinking water suppliers and to the public at large. Second, a lot of MCLG's are set at zero. We are dealing with a statute that talks about risk, reasonable risk, and unreasonable risk, and zero, in the context of FIFRA is not a very practical goal to try to achieve. I think that certainly in practice, MCLS are often set very near where the MCLG is, and we must also remember that we are using these as a reference point and that this is not the end-all and be-all for the pesticides in ground water strategy. We may, in fact, look at a particular chemical, decide that the MCL is either too low or too high, given the particular benefits compared to its risks, but we feel that it is incumbent upon us in the Pesticides Office to explain if we are going to deviate from a drinking water standard, either up or down, because we need to use that as a reference point and explain why we are deviating.

Mr. OBERSTAR. Years ago, in the dawn of the Clean Water Programs, 1956–57, we talked about health-based standards for water and eventually moved to other objectives and other means of evaluation and then the Clean Water Act of 1972 set up goals and objectives, and brought much more detail. I think that as science and the private and public sectors both learn more about pesticides and their long-term effects and behavior in soils, we may move in that direction as well. Goals seem to give us more of a yardstick by which to measure progress in managing persistent substances in our environment. It seems to me that ought to be a factor in the EPA thought process.

Ms. WAYLAND. I certainly agree with what you have said, Mr. Chairman. I think that when we are talking about the goal here, and using drinking water standards as the goal, that we are looking toward public health protection, but we also have to consider the benefits of the pesticides as required under the statute that we administer.

Mr. OBERSTAR. Yes, I understand and I will come to Dr. Miranowski on the matter of costs and benefits in a moment. You also mentioned that EPA is reevaluating existing chemicals that predated the FIFRA Act, and that is required by law as well. When I graduated from high school, there were about 500 chemicals used in pesticides. I grant that was quite a few years ago, but today there are 40,000 chemicals used in pesticides. How are you going to evaluate all of those and how much progress is being made? I am thinking also of the Clean Water Program where we had evaluations and standards to be set and EPA has had a very difficult time completing that work.

Ms. **Wayland**. Mr. Chairman, things are not that different from when you were in high school in terms of how many active ingredients we have registered. That is the difference in the numbers—we are really talking about 600 basic active ingredients and their metabolites that we are looking at in our reregistration program. Those basic active ingredients are then formulated into some 40,000 to 50,000 individual products. As we go through chemical by chemical in our reregistration program, we are looking at the basic chemical, not each individual formulated product. The data associated with the active ingredient is the data that we need to assess ground water vulnerability, as well as the basic toxicology and exposure.

Mr. **Oberstar**. Your review is limited then, more to the chemical composition and the basic active ingredient that may be present in a number of pesticides, rather than doing it on a trademark-by-trademark, name-brand-by-name-brand basis, is that correct?

Ms. **Wayland**. That is correct. We are doing chemical by chemical, and obviously the use patterns and whether or not there is some unique formulation associated with those use patterns will be taken into account when we assess the exposure of those chemicals to either humans or the environment, but we find that it is far more efficient to go on a chemical-by-chemical basis than a product-by-product basis in our program.

Mr. **Oberstar**. I think that is a sound approach and I am glad to hear that. I am glad to hear that the Agency is looking at basic chemical structure. That reduces your universe and makes it possible to complete evaluations in a much more timely fashion. How far along are you? How many of these basic formulations have been evaluated or reevaluated?

Ms. **Wayland**. We have gone through the reregistration process for approximately 200 of those chemicals. We hit the higher-use chemicals first. We had a rating scheme when we went about the development of our priority list and chemicals that were used on food and chemicals which have higher production got to the front of the line. So those 200 chemicals that we have looked at to call in the data for both toxicology and environmental fate and other effects, were chemicals that have primary exposure to the population.

Mr. **Oberstar**. In this process of evaluation, is the Agency also examining how those chemicals behave in or on soils of different kinds?

Ms. **Wayland**. Absolutely, yes.

Mr. **Oberstar**. What are you finding? Do you find different behavior problems in different soils and different acidity levels?

Ms. **Wayland**. Yes. We have, as you alluded to in your opening statement, been very much aware since the late seventies, that we were facing a problem of pesticides leaching into ground water. We have since that time developed a fairly elaborate package of data requirements on environmental fate for all pesticides that are used outdoors. The chemicals vary tremendously in their persistence, their binding or nonbinding to the soil, their ability to degrade in sunlight, the ability to leach below the soil surface, and, depending upon the soil type and the chemical composition, we are finding that there is a great variety in chemicals.

When we looked first at our pesticides in ground-water survey, we determined those chemicals that we felt had the greatest potential to actually remain in the soil, to penetrate to the lower levels beyond the root zone, and to reach ground water. So, we do have a lot of variation between chemicals and soils, yes.

Mr. OBERSTAR. This information is very important for agriculture, and yet, I think a problem arises if you say we are going to research this to the Nth degree—we will make no progress at all. Yet that kind of information is important in evaluating chemicals and their behavior in the soil and how soon and in what way they will affect ground water. Also, I think the filtering capacity of soils and their inherent treatment capability must also be considered. You mentioned the ability of some chemicals to break down in sunlight, and some bacteria in soils may act to break down some of these chemicals and they may not. They may be able to simply move right past those active zones in the soil.

Mr. Miranowski, you did address the matter of costs and benefits in a general way—what data do you have on lands where there is no treatment with pesticides and those where current state-of-the-art chemical application is used, and what the difference in yields might be?

Mr. MIRANOWSKI. Mr. Chairman, in terms of the effort in this particular area, we have been involved for a number of years in the innovative pest management programs which do not eliminate the chemical pesticides, but use those as part of the process while aiming toward reduced use of pesticide chemicals in production. In terms of the no-use alternative versus current-use levels, there is work underway that looks at the impact of reduced chemical use on production activities as part of in our research activities in the Economic Research Service. There is other work that has been underway in the new low-input program that is funded through CSRS and we will be looking at some of the same questions over the next couple years as part of that effort. That is about the extent right now in terms of comparing yields under no-treatment versus current-level treatment.

Mr. OBERSTAR. The current drought raises an interesting dilemma. Certain types of pests are warded off by healthy, succulent plants that are full of life when they are growing with plenty of rainfall and sunlight. Those same crops, withered by drought, become an attractive place for pests that are otherwise warded off by the plant itself. There may be a temptation now to use pesticides as a preventative toward next year when insects may be chomping away, as they are laying eggs now that will sprout in vast numbers next year, and there may not be too much concern about penetration into ground water, since we do not have much surface water. There has been very little rainfall, so there is nothing to percolate down. What attention is the Department giving to that issue?

Mr. **Miranowski**. The Department has the position, essentially, of encouraging wise and prudent use of pesticides. As part of that, we feel that it is extremely important that wise and prudent use is coupled with profitable and competitive agriculture. At this particular point in time there is a very limited amount of evidence—we do not have any data on what is being anticipated out there in terms of pesticide use—but there is very limited evidence given that drought is not a common pattern through much of this country, very little evidence in terms of the damages in a drought year versus other years. My personal research in years back indicated that was true in terms of Corn Root Worm control. In fact, in a drought year you could have more serious problems. Again, as we talked about earlier, just as the pesticide chemicals degrade differently depending on the different environment soils situation, pest carryovers from year to year, survival rates, and so forth vary a lot with weather conditions. So it is very difficult to say, given drought conditions this year, even if more eggs are laid, what the survival rate is going to be and what the potential damage will be in the following year. There is really very little data to document that or support concern about a serious problem next year.

Mr. **Oberstar**. That certainly would be true for the last 15 years or so. We have had above average rainfall throughout the Midwest.

I will have further questions, but I will now recognize the gentleman from Pennsylvania, Mr. Clinger.

Mr. **Clinger**. Thank you very much, Mr. Chairman.

To follow up on the chairman's question, Ms. Wayland, you indicated that you have now reviewed 200 of potentially 600 chemicals that are employed in the over 40,000 brand-name pesticides on the market, is that correct?

Ms. **Wayland**. Yes, we have reviewed the databases on 200 of those chemicals and have called in data that was found to be missing.

Mr. **Clinger**. Of those chemicals, how many have been determined as not being able to be recertified, and therefore, had to be banned?

Ms. **Wayland**. We have put several of those chemicals into our special review process. One of the chemicals that came up in reregistration was dinoseb, which we took emergency suspension against. A lot of the chemicals that are now in our special review process, including aldicarb, carbofuran, telone, and various others, come out of the reregistration program where we had concerns about the potential effects of those chemicals, not only on ground water, but other effects.

Mr. **Clinger**. When do you propose to finish this recertification process?

Ms. **Wayland**. We are estimating that at the current level of doing 25 chemicals per year, that it will take us until shortly after the year 2000 to really finish all of the reregistration requirements. The point that I was making earlier is that we have put these chemicals in a queue so that we are looking at the higher-exposure pesticides first. We are trying to get at the databases for those chemicals and to mitigate whatever risks might be posed earlier, rather than later, in that process. I think you probably know that this has been a very big issue in FIFRA reauthorization. I think

Dr. Morris testified on many occasions before committees of both Houses, for our need to get on with reregistration, and we have appealed to the Congress to help us do that.

Mr. CLINGER. As a practical matter—you are proposing to review about 25 per year—if you had more resources, would you be able to accelerate that?

Ms. WAYLAND. Yes. I think one of the provisions of the new FIFRA amendments would give us the resources through a fee system that would permit us to accelerate reregistration, and that has been one of the primary issues that has been discussed in both Houses.

Mr. CLINGER. The EPA's 1984 survey found 24 States in which residues of at least one of 19 pesticides were found in wells, and the Economic Research Service, based upon certain finite data, estimated the potential pesticide contamination of the ground water of 814 counties located primarily on the Eastern Seaboard, Gulf Coast, and the Upper Mid-West. In those two surveys and the analysis arising from them, has there been any attempt made by either of your agencies to identify how much of the pesticide contamination comes from point sources, leaks, spills, etc., and how much comes from nonpoint sources, which would include agricultural application? Do we have any reliable data as to what the breakdown is between point and nonpoint sources?

Mr. MIRANOWSKI. In terms of the Department, to the best of my knowledge, we have no breakdown or survey data that would indicate how much might come from accidental spills and things of that nature versus the nonpoint broader application.

Ms. WAYLAND. May I follow up on that?

Mr. CLINGER. Yes.

Ms. WAYLAND. The figures that I was using in my testimony are figures based upon what we consider to be the normal agricultural use of chemicals as opposed to the point sources. We are right now going through the data that we have received since that earlier report came out in 1984, going back to try to determine to the best of our ability what are the point sources, the spills, the mixing/loading areas, or accidents versus nonpoint sources through normal agricultural use. So we are addressing that problem, but we do not have what I would call a very exquisite database right now. We are looking at it, and I think a lot of the States are also pursuing that.

Mr. CLINGER. Do I understand that what you are saying is that the 1984 data assumes that these were all normal applications and, therefore, nonpoint sources?

Ms. WAYLAND. What I am saying is that we went back and looked to the best of our ability without doing a tremendous amount of research. We went back to try to determine which of those pesticide incidents were from nonpoint source contamination as opposed to leaks, spills, and accidents.

Mr. CLINGER. Should the ERS study be taken as a reliable indicator of where ground water contamination by pesticides is found, or would it be better utilized as a predictor of locations where ground water contamination is likely to be found? In other words, is EPA's national well-water survey concentrating on those areas identified by the ERS, and thus serving to test those predictions?

Mr. Miranowski. Let me just respond to answer the first part of your question, the ERS study is only an indicator of the potential for pesticides to leach the ground water. It is not in any sense an indication of where the ground water is contaminated with or has high levels of——

Mr. Clinger. Just the potential?

Do you have anything to add to that, Ms. Wayland?

Ms. Wayland. Obviously, we are going to be looking in our national survey at areas that have high use and high vulnerability, which was the focus of the USDA survey. We want to get better data on those scenarios.

Mr. Clinger. So you are using their data, in other words, to——

Ms. Wayland. We are not really using their data, but we are using a lot of the concepts as expressed in that paper and looking at high use areas and high vulnerability areas, using a DRASTIC approach, which is what the USDA report based its estimates on.

Mr. Clinger. Can you tell us Mr. Miranowski, what the DRASTIC score is, in layman's terms?

Mr. Miranowski. The DRASTIC score, as we used it in our analysis, simply uses a number of different characteristics of the soil that give you an indication of the possibility of leachable or water soluble pesticides to move down through the soil layers to the ground water table, the aquifers. It simply brings together seven characteristics of soils that would make it amenable to transport down to the ground water. We used equal weights for the 38 pesticides that we were considering. Further refinements and different weights on particular chemicals would be informative if with particular chemicals greater impacts in terms of the ground water quality were involved. It is simply a measure of how the ground is like a sieve in terms of allowing the more soluble ones to get down to the ground water.

Mr. Clinger. Of those pesticides which you have detected so far in ground water, can you give us any general idea what the levels of concentration have been? In other words, are we looking at concentrations which could be associated with acute toxic or chronic health effects?

Ms. Wayland. I think that as a general rule the levels that we are finding are in the low parts-per-billion. I think that is true in a lot of the State surveys. You are going to be hearing a State panel in a few minutes, and Minnesota, which is one of those States, has conducted a fairly extensive survey. We are generally finding that from nonpoint sources, we have low parts-per-billion which are typically not exceeding health thresholds. Where we do exceed health thresholds, it is because of a point source problem, and accident, a spill, or whatever.

Mr. Clinger. You are saying that in the areas where you have exceeded the threshold, it is attributable to the fact that there has been a point source causing that to spike, correct?

Ms. Wayland. As a general rule, yes.

Mr. Clinger. I will have some further questions, but I am sure that my time has expired.

Mr. Oberstar. The gentlewoman from Maryland, Mrs. Bentley?

Mrs. Bentley. Thank you, Mr. Chairman.

Mr. Miranowski, your statement cites the DRASTIC score as one measure of potential pesticide contamination.

Mr. **Miranowski**. That's correct.

Mrs. **Bentley**. Could you tell the subcommittee in plain terms just what the DRASTIC score is?

Mr. **Miranowski**. Let me attempt to do that. Maybe my counterpart from EPA can help me out a little, in that they have actually supported the development of this particular index. The DRASTIC score can range up to as high as about 245, based on the type of analysis that we use. This particular score simply indicates that if it is in the higher range—in terms of our study, we indicated at about 145—that particular DRASTIC index measure and above was considered a high level of possibility of potential for leaching into ground water. If you take a particular pesticide and follow its fate in transport, that particular pesticide just has a higher probability in a particular soil and climatic condition of migrating down to the ground water. That was the basis of the interpretation that we used to the DRASTIC index in our analysis.

Mrs. **Bentley**. Based on that, you say in your statement that, "Over 1,100 of the 3,100 U.S. counties were considered susceptible to pesticides leaching to ground water based on this procedure and 361 counties had both a high DRASTIC score and high pesticide use." Are any of these in Maryland?

Mr. **Miranowski**. I would have to look back at the study in order to answer specifically, but I would be glad to provide that information for the record.

[The following was received from Mr. Miranowski:]

In Maryland 13 counties had high DRASTIC and high pesticide use; 8 counties had medium DRASTIC and high pesticide use; 21 counties (of 26) potentially vulnerable.

Mrs. **Bentley**. Why is it that of all the pesticide types, we understand that herbicides are the ones that are most commonly found in ground water?

Mr. **Miranowski**. The interpretation that I would give to that is the leachability and the water solubility of it and the fact that herbicide use has grown significantly in recent years. The combination of the use levels, coupled with the solubility and leachability of that particular chemical is what would be the reason that herbicides would be the major one that would leach down to ground water.

Mrs. **Bentley**. Mr. Chairman, that is all the questions that I have for now.

Mr. **Oberstar**. In answer to the gentlewoman's question about the effect in Maryland, there is a document which has been published by the Department of Agriculture, which purports to map the entire United States and, at least in general terms, the gentlewoman's questions can be answered there.

Mr. **Miranowski**. I might just add, Mr. Chairman, that looking at the map of Maryland which I now have before me, I see that this indicates that the pesticides definitely have the potential in a number of Maryland counties, as well as nitrates in some.

Ms. **Wayland**. Could I also add one point here?

Mr. **Oberstar**. Yes, please.

Ms. Wayland. When we proceeded with our well-water survey, one of the first things that we did was to attempt to apply DRASTIC scores to all of the counties and then to overlay that with high, low, and medium pesticide use, and we would also be very happy to provide our map which overlays the high use and high venerability areas for your consideration and the subcommittee's consideration.

Mr. Oberstar. We would like to have that.

[The document referred to: "The Magnitude Of Costs of Groundwater Contamination from Agricultural Chemicals: A National Perspective", U.S. Department of Agriculture, Economic Research Service, Report No. 576, may be found in the appendix. See page 323.]

Mr. Oberstar. How did the agency decide which ground waters to protect, Ms. Wayland? What was the process by which you reached that decision?

Ms. Wayland. Mr. Chairman, as you probably know, there is a 1984 Agency Groundwater Protection Strategy.

Mr. Oberstar. Yes.

Ms. Wayland. We have tried to attempt to fit our strategy on pesticides into that over-arching ground water strategy. You are probably also aware that the 1984 Strategy has proposed that there are several categories of ground water for protection, Class I, Class II, and Class III. When we looked at pesticides and use of pesticides and where those pesticides were found in the typical aquifer situation in most agricultural areas, we determined that probably most of the pesticide areas that we would be worried about would fall into what the ground water classification scheme would call Class II. Therefore, we have concentrated our efforts and our strategy in looking at Class II situations, which means primarily current and potential drinking water sources, and that is where we have put the focus of our strategy.

Mr. Oberstar. That was done within the Agency's overall approach to evaluations?

Ms. Wayland. Yes, sir.

Mr. Oberstar. You have used the term "negligible risk." Would you explain EPA's concept of and its justification for negligible risk?

Ms. Wayland. Mr. Chairman, in the strategy we have proposed that when there is no MCL to guide us as a reference point, we will do one of two things. For chemicals that have a threshold effect, we are going to be looking at either MCLG's or health advisories, where we can come up with toxicological enpoints, apply a safety factor and exposure factors to that enpoint, and come up with a level that we find to be an acceptable level of exposure. For carcinogens, as you know, it is a very difficult issue and we have attempted in this strategy to at least propose that we would use a negligible risk concept as the reference point for where risks may exceed benefits, and that negligible risk as we have stated it in our strategy would relate to one-in-a-million probability.

Mr. Oberstar. There is always, of course, the temptation to urge further research and further studies and to not apply these standards of risk and loosen things. We are really talking about human health, and in the case of agricultural chemicals, perhaps more than urban and suburban application of chemicals, where urban and suburban residents are drawing water from community drinking water supplies far away from their property, the rural areas are drawing water directly from the soils to which are being applied the chemicals that are contaminants, both for themselves and for their livestock. There is a real concern about this matter of negligible risk—to whom, and under what circumstances, and what cost?

Ms. WAYLAND. Mr. Chairman, if I could just go back a second, you probably are aware that the National Academy of Sciences, at EPA's request last year, did issue a study on the similar issue of pesticides in the diet. This is philosophically very similar when we start talking about pesticides in ground water, because we are very worried about dietary exposure. The NAS came out with this notion of and recommendation to EPA about looking at the concept of negligible risk in the regulation of pesticides in dealing with food uses. We thought that made a lot of sense. We are marching toward a policy that would try to articulate how we are going to apply negligible risk for food uses, and we thought that in the ground water strategy that concept was just as applicable when we are talking about what is really another type of dietary exposure.

Mr. OBERSTAR. It certainly is. That is very interesting to know and I appreciate your mentioning it. Has EPA worked with the Department of Agriculture in its well-testing project?

Ms. WAYLAND. We have been very much involved with the Department of Agriculture in every step of the way in developing our well-water survey. We have involved the Department in the conceptual phase of designing the survey. We have met with them numerous times in coming up with the design and making sure that the statistical design of the survey was one that we could all agree was a good and sound one which would give us the results that we want. We are constantly briefing the Department of Agriculture on our progress in the survey, and we are even talking about how the Department of Agriculture can help us to achieve those ends. One of the things that USDA is doing for the survey, for which we are very grateful, is using its Extension Services to help us get information on pesticide usage at the local level.

When we go into a State and we are actually selecting the wells for this survey, we are going to depend to a large extent on the Extension Service Agent's knowledge of what pesticides have been used over what period of time to help us select the wells that we are going to be testing, so yes, we have had a lot of cooperation from USDA.

Mr. OBERSTAR. I am glad that you are working with the Extension Agents because they really are the best. They are out there on the firing line day after day. They know their counties, they know the soils, they know the farmers, they know what is being applied to the land, and they can tell you what you need to know. And the elevator operators and feed mill operators—they sell the product to the farmers. They know who is applying what in what quantities and what soils. Those are very important people to be in touch with.

Mr. Miranowski, can we have your evaluation of the progress on this survey.

Mr. **Miranowski**. I would just like to add that we feel very strongly that a close working relationship on this survey is absolutely essential. We collect the data on pesticide use and pesticide application levels, and only if we can start linking up the data on use and application levels and the data on the fate of those eventually in ground water, can we develop the guidelines and the tradeoffs of all the different policy alternatives. So we feel that it is absolutely essential to maintain a close working relationship and to have ongoing input into that effort as we have in the past. I think that we will then be able to come up with much more specific responses to the types of questions that we would all like to see answered and how best to address this issue.

Mr. **Oberstar**. How far along is this survey, when do you anticipate that it will be completed, and what are you going to do with the result?

Ms. **Wayland**. The survey will take place in 1988 and 1989. We will be sampling through both those years and we hope to have a final report in 1990. The results will help us a great deal, first of all, in just determining the extent of the problem and where we need to focus our resources in addressing the issue. I think it is going to help us to focus monitoring requirements, and help the States in doing State management plans on how to actually control the use of chemicals in high vulnerability areas. It will be used by our Office of Drinking Water to set priorities in determining which pesticides they need to develop MCLS on and what pesticides need to be monitored for both in the pesticide industry, as well as in the context of the Safe Drinking Water Act.

Mr. **Oberstar**. That is very helpful, and I appreciate getting a sort of look ahead.

On page eight of that manual that I referred to earlier, Mr. Miranowski, there are listed a number of pesticides with an EPA description, "leacher, mobile, persistent, moderate leach, and marginal leach." A later witness will say that most pesticides "do not leach." Would you describe that as an accurate chemical and behavioral statement, given this long partial list of pesticides which do, in fact, leach?

Mr. **Miranowski**. I am not a chemist by training, so I can really only comment in terms of our understanding of the nature of these chemicals. To the best of my knowledge, those that are water soluble and do not bind tightly to soil particles do have the potential to leach down into ground water. Again it depends upon the particular chemical and the particular soil environment. Basically we rely on the expertise of the chemists and agronomists that have worked with EPA on these chemicals.

Mr. **Oberstar**. Ms. Wayland, of the pesticides surveyed so far and analyzed by EPA, what is you reaction to that characterization?

Ms. **Wayland**. I think we could put this in context. We talked a little earlier about the fact that there are 600 active ingredients. We have identified some 100 pesticides for which we have called in extra data because of our concern about the ability of those chemicals to leach. Those are the chemicals for which we already have the chemical characteristics that have given us some cause for further investigation. We have selected about 60 pesticides that we are particularly worried about, so that the universe that we are concerned about right now is slightly over 100 pesticides that we are really doing a lot more investigation on out of the universe of 600 active ingredients.

Mr. **Oberstar**. Does your response mean that the EPA has, in fact, evaluated the leaching properties of all of those 600 chemicals?

Ms. **Wayland**. We have asked our ground water team to go through the basic chemistry of the pesticides that we now have on the books and to identify those because of their chemical characteristics. These chemicals have not all gone through the full reregistration program that we were talking about earlier. We have asked our experts, our chemists that work in the ground water part of my program, to give us their best estimate based upon the chemical characteristics of those ingredients as to which ones we really need to look at first.

Mr. **Oberstar**. If that characterization is now accurate and holds up under further analysis, then it would be correct to say that if 100 of the 600 are leachable chemicals and the others are not, then most do not leach, is that correct?

Ms. **Wayland**. We really do not know enough about that. I think that right now we are on a learning curve with pesticides in ground water. The estimates that I was giving you really are the best guesses of our chemists right now. Of the 600 chemicals, a lot are not agricultural chemicals at all, but when you talk about these numbers and put them into context, you have to really know what universe you are talking about. Of the agricultural chemicals, we have slightly over 100 that we are at least concerned about and need to do more investigation of.

Mr. **Oberstar**. Section 304(k) of the Clean Water Act gives EPA authority to transfer money to USDA and to work with the Department of Agriculture on regulatory as well as voluntary protective measures. To what extent does EPA operate under that grant of authority? How much money, if any, is being transferred to USDA for those purposes and what is the extent of joint effort on regulatory and voluntary protective measures?

Ms. **Wayland**. I am really not sure how much of the funds under the Clean Water Act have gone to USDA, unless Mr. Miranowski might have some indication.

Mr. **Oberstar**. Fine.

Mr. **Miranowski**. I cannot add to that, Mr. Chairman.

Mr. **Oberstar**. As a matter of applicator training, in light of the farm bureau witness' statement that, "The causes of the problem generally are not routine field application, but rather a point source factor, such as shallow wells, unique soil characteristics, improperly cased or cracked wells, or mixing and loading too close to wells," if the location of the well with respect to application of pesticide is, in fact, a prime factor in contamination of ground water for drinking water purposes, then applicator training becomes a very important factor, as well as the labeling of pesticide containers. If all pesticide containers for agricultural use are labeled as they are for homeowner use, then you need a magnifying glass to read the darn thing. Would you tell me about the applicator training program and its relationship to those representations by our Farm Bureau witness?

Ms. **Wayland**. I think that their representations are correct to the extent where we have found the most significant problems. We said earlier that a lot of the really high values of pesticides in ground water can be attributed to point sources. The applicator training and certification manual that I alluded to in my testimony goes into those issues in great detail, and we try to get into what causes pesticides to reach ground water and what kind of quantities. This manual goes through the point sources, the mixing/loading sites, the disposal of containers, the proximity of wells, and the well construction. All of those things that you just mentioned, Mr. Chairman, are in this new training manual and this is directed at the farmer. It is what we hope will be a very practical guide concerning what you, as an individual farmer, can do to mitigate pesticide contamination of ground water, and it will talk about point sources as well as non-point sources. I think that we have certainly recognized the need to get education out into the field on those points that you have just mentioned, and I should also say that the private sector has developed a lot of training films along those lines. I am not really familiar with all of that, but perhaps you could ask Dr. Early when he testifies a little bit later what the private sector has done, because they have attempted to address this kind of problem with training materials that are now out in the field.

Mr. **Oberstar**. Thank you very much.

The gentleman from Pennsylvania, Mr. Clinger.

Mr. **Clinger**. Thank you, Mr. Chairman.

Ms. Wayland, with regard to the ongoing ground water survey I think you said that 600 community water system wells and 750 domestic or private household drinking water wells have been selected for the survey. How were those selected? What were the criteria for selecting those, and how widely dispersed are they throughout the country?

Ms. **Wayland**. The survey is basically a three-stage design. The first thing we did was to go through and try to characterize the vulnerability of counties throughout the United States to leaching of pesticides. We then went back and looked at the use of pesticides across those counties. We primarily built a matrix where we had high use and high vulnerability as one of the characteristics, medium use and medium vulnerability as a characteristic, and low use and low vulnerability as a characteristic. We tried to put the counties into those boxes as we screened in the first stage of that design. We then went back, in the second stage, and attempted to refine those estimates, to go back to the high use and high vulnerability areas to try to find where in those counties were the highest vulnerability spots where the pesticides that we are most concerned about are used most frequently. We are narrowing down—we started with the universe of the whole United States and every county in the United States. We divided those counties into three different piles, if you will, and now we are going through to try to refine those piles. The basic survey is going to look from every one of those cells in the matrix, because we do not want to look just where we think there is going to be a problem. We also want to look where we do not think there will be any problem to see if we are right.

Mr. CLINGER. So the wells that you are going to be monitoring are dispersed throughout all three categories?

Ms. WAYLAND. Yes, and they are dispersed throughout the United States, so we may be picking several wells within the State of Pennsylvania that are low, and some wells in the State of Utah, for example, that may be high. Now I just made those up—they are not based upon where the counties fell out according to my survey.

Mr. CLINGER. That gives me an idea how the selection is going to be made. What is going to be the procedure about the actual monitoring itself? Of the 1,300 or so wells that are going to be ultimately involved, are you going to be testing them on a one-shot basis to determine what is there on a snapshot, or are you going to have some sort of a spread over a period of time and test them two or three times?

Ms. WAYLAND. Basically, to answer your question, we are taking a one-shot snapshot. That is the most direct answer that I can give. However, we will be going back to look at wells where we have received positive readings in order to verify the samples that we have taken. The wells on the community side are really being done with the aid of a database because we do know where the community wells are in this country and there is a database that helps us find those and figure out which category those wells might fall in. On the domestic side of the survey, of course, there is no good database on where private wells are, so we are having to do a lot more elaborate work in trying to find the wells to test on the domestic side of the surveys, talking to Extension Service Agents and talking to individual well owners in order to choose the wells that fall into the right mix for our survey.

Mr. CLINGER. Are you satisfied that this will be sufficient? Are you satisfied that there is not wide variance in wells from one time to another?

Ms. WAYLAND. That has really been one of the issues. How do we deal with the temporal variability? It has been one of things that has been most difficult for us in the design of this survey. We have taken the statistical design to a scientific advisory panel twice, and we have gone through a lot of peer review. We think that we will have a good indication of the extent of contamination throughout the country.

Mr. CLINGER. Where you find contamination, you will retest, correct?

Ms. WAYLAND. Primarily we will be going back to verify the results. We are really not trying to do that in terms of getting a handle on temporal variation.

Mr. CLINGER. It is my understanding that many, perhaps most, pesticides tend to break down over a period of time and to become less toxic. Has any study been done to determine what effect the dilution in ground water has on that breakdown process?

Ms. WAYLAND. I do not think I have very good information on that point today. I could certainly try to provide more for the record. What we do know is that in areas where we have found ground water contamination, when we go back and look we find that even years after the initial finding, we are still finding significant levels.

Mr. Clinger. In the ground water?

Ms. Wayland. Yes.

Mr. Clinger. That is all that I have, Mr. Chairman.

Mr. Oberstar. Thank you.

Gentlewoman from Maryland, Mrs. Bentley.

Mrs. Bentley. Now that I have this ERS report, a little bit of the information in there is rather startling to me. For instance, where it talks about the numbers of pesticides that were found in ground water caused by agricultural practices in 1986, it shows that Maryland has five, and there are only three States that are higher, at six. Maryland is all by itself in the fifth category.

We are all very concerned in Maryland about the Chesapeake Bay. Am I right in thinking that the high number of pesticides are definitely polluting the Chesapeake Bay?

Mr. Miranowski. In terms of our particular analysis, we did not attempt to make any link between what was happening with surface water or what the potential would be to get the leaching to drain into surface water, so I can not comment in terms of what impact it might have on the bay. Surface water systems and ground water systems are frequently linked, and one would expect to find some linkages, but based on our study I can not address that.

Mrs. Bentley. The other interesting statistic in here is the fact that 91 percent of our counties, or 21 out of the 23, are potentially contaminated. I think Maryland then, is probably one of the States most drastically affected by all of the pesticide application, and yet we know that agriculture is a very important industry in our State. What are we going to be able to do about it?

Mr. Miranowski. The Department's perspective on this is that we want to insure prudent and wise use of agricultural chemicals while also protecting and enhancing ground water quality. There are a number of activities through our technical assistance programs within the Agency that we use to try to convey to the farmers the terms of what constitutes wise and prudent use and what would contribute to maintaining and enhancing ground water quality.

Mrs. Bentley. Thank you, Mr. Chairman.

Mr. Oberstar. Thank you very much.

We have a vote in progress on the floor but I do have to ask you, Mr. Miranowski, to explain what is meant by this statement. When you say, "that it is not national in scope," what are you referring to?

Mr. Miranowski. Mr. Chairman, maybe that statement could be worded a little more effectively. What I am attempting to say there is that it is not universal in scope and that the problems are concentrated in a subset of the counties. We are looking at approximately a third of the counties across the Nation that have the potential for pesticides to leach into ground water. Those counties are clustered areas, to a degree at least. From a policy point of view that may dictate a different policy or have different tradeoffs in looking at policy alternatives than if we had 2,000-plus counties with a high potential. Surface problems are going to potentially exist wherever pesticides are applied. Ground water problems are limited to a third, as more information becomes available, it may even be a smaller subset of countries, particularly if we can eventually link use and contamination of ground water. At this point we are only looking at potential, so we are probably more encompassing than we will be in the end.

Mr. **Oberstar**. Also on the same page, you make reference to the expenditures and costs of a monitoring program and then go on to say that this $900 million to $2.2 billion cost does not include acquiring water from alternative sources or treatment for potentially contaminated water. Can water in place be treated?

Mr. **Miranowski**. There are a number of technologies of varying quality and effectiveness. They range from activated charcoal filters that can be put on a faucet to systems that treat a whole house, depending on whether you are looking at nitrates, pesticides, or both. I am not really up on the technologies there. The costs in our study can range anywhere from something that is $25 to $50 where you put an activated charcoal filter on your faucet, to a system that may be $800 or $900 for a household. Again it depends on which chemicals—we may not be able to treat for all chemicals—but there are different treatment possibilities available.

Mr. **Oberstar**. Where you have livestock that need water, treating the enormous quantities that are required there may be very expensive indeed.

Mr. **Miranowski**. It could be very costly in certain circumstances, yes.

Mr. **Oberstar**. I would just like to mention for our witnesses and for those who are gathered here with us this morning, that we had a hearing four years ago of this subcommittee, in Santa Clara County, California, in the heart of Silicon Valley at San Jose, California, where the giants of the computer and microchip industry are located, and where they treat the manufactured computer chips to clean them before they go on for further processing with a chemical called TCE, trichloroethylene. A very extensive underground system of storage tanks to receive the used TCE was established throughout the area with very elaborate State/Federal review and controls, and nonetheless, TCE showed up in not one, but three aquifers. This had been an agricultural area, and three separate levels of aquifer had been perforated to provide water for farm purposes. Of course it is now all settled, but the people are showing three times the national average of birth defects, deformities, and cancer rates, and the only way they could think of to deal with that problem was to pump the water out of the aquifer onto the surface and hope that the TCE would evaporate into the atmosphere, where God knows what it would do. That is what they were doing, and what an ecodisaster that situation is. It is a graphic example for us of how we must be preventive and farsighted in not allowing this precious reserve of water to be destroyed by our thoughtlessness. We have an opportunity here to look ahead at pesticides and to deal with that problem, and we must be wise and err on the side of caution if indeed we err at all.

We have a vote in progress. I want to thank the panel for their very fine presentation.

[The prepared statements of Ms. Wayland and Mr. Miranowski follow:]

TESTIMONY OF
SUSAN H. WAYLAND
DEPUTY DIRECTOR
OFFICE OF PESTICIDE PROGRAMS
OFFICE OF PESTICIDES AND TOXIC SUBSTANCES
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
OF THE
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
UNITED STATES HOUSE OF REPRESENTATIVES

August 11, 1988

Good morning, Mr. Chairman and members of the Subcommittee.Today, I would like to discuss the activities EPA has underway to address the pesticides in ground water concern, including the Agency's nation-wide pesticide survey and the proposed Agricultural Chemicals in Ground Water Strategy.

BACKGROUND

Ground water provides about one-fourth of all the water used in the United States. It is the source of drinking water for nearly half of the total United States population, and is particularly important in rural areas.

Over the last several years, concern about pesticide contamination of ground water has grown as reported findings of pesticide residues in ground water have increased. In 1984, the Agency found that 24 states had reported the presence in at least one well of residues of at least one of 19 pesticides in situations where it appeared that the pesticide's presence could be attributed to the approved use of pesticide products. EPA has cancelled some pesticides' registrations based in large part on findings of potentially dangerous levels of their residues in ground water.

A number of states have also taken or are beginning to take measures to better understand and address the problem. These steps include monitoring, developing ground water protection strategies, setting ground water standards, and establishing regulatory and non-regulatory management approaches.

NATIONAL PESTICIDE SURVEY

EPA has taken a number of steps to address concerns about pesticides in ground water. First, the Agency is getting better information on the national scope of the problem. We are conducting a representative survey to determine both the frequency and level of pesticide concentrations in both domestic and community drinking water wells and also how pesticide concentrations in wells are associated with pesticide use and ground water vulnerability near those wells. We are looking for 126 substances (including some 60 pesticides with leaching potential, and nitrates and nitrites from fertilizers), in 600 community water system wells and 750 domestic or private household drinking water wells. The full survey is now underway, and we expect to report the complete findings in early 1990.

A key component of this survey effort has been the development of draft health advisories for over 60 pesticides. These health advisories summarize all the toxicolgical information on pesticides and provide EPA-determined levels that would be considered to pose some health concerns if found in drinking water. The health advisories will help provide a context for evaluating the health significance of the findings of EPA's national survey, as well as other monitoring studies.

REGISTRATION REQUIREMENTS

The Agency also requires manufacturers or registrants to submit extensive environmental and toxicologic testing and other information on their products in order to make registration decisions. Under FIFRA, EPA has established basic testing and information requirements to determine the potential for pesticides to "leach" to ground water. The Agency now screens all new pesticides or proposed new uses of existing pesticides for groundrwater contamination potential. We have declined to approve, or placed certain conditions on, the registration of some pesticides because they appeared to pose unacceptable ground water contamination concerns. In 1984, through a special data call-in and other registration procedures, EPA required the registrants of 140 existing pesticides to provide data to adequately determine the potential of these chemicals to leach. The Agency has been reviewing these data to identify pesticides that will require more testing or regulatory action. The Agency is also requiring more soil and ground water monitoring by applicants and registrants.

Under its label improvement program, EPA has recently established ground water safety requirements for the application of pesticides through irrigation waters, a practice referred to as chemigation. EPA stated that product labels either must forbid chemigation use or be amended to require the use of anti-backsiphoning devices and other management practices designed to prevent possible ground-water contamination.

CLASSIFICATION

The Agency is also developing a proposed rule for placing pesticides that pose ground-water concerns into a restricted use category. A pesticide in this category can only be obtained for use by an applicator who has been trained and certified by state pesticide programs. The Agency has also developed and distributed to the states a ground water training module for their applicator training programs. States will be able to use this module in their training programs this fall and winter.

CLEAN WATER ACT

EPA is also providing guidelines and support to the states to establish strategies and programs that can address various aspects of the concerns about pesticides in ground water. Under the Clean Water Act, EPA has for several years been providing funds to the States to develop their general ground-water protection strategies. A number of these state strategies have identified pesticide contamination as a priority ground-water concern and have undertaken various measures to address potential problems.

SAFE DRINKING WATER ACT

Under the Safe Drinking Water Act, the Agency is setting MCLGs and MCLs for 51 Aagricultural chemicals providing guidelines to the States for establishing wellhead protection programs. Under a wellhead protection program, a state identifies the major recharge areas of public wells and then establishes a plan to manage the potential ground-water contamination sources that lie within those designated areas. This program may provide valuable additional support to the States' efforts to control the use of agricultural chemicals to prevent contamination of public water supplies.

EPA'S PROPOSED PESTICIDES STRATEGY

EPA has acted vigorously to protect ground water from unreasonable pesticide contamination. This activity has led people to ask: (1) Do the Agency's efforts reflect a coordinated approach? (2) How do the Agency's efforts fit with other federal agencies and the States? and (3) Should the Agency strive for some national consistency in how the pesticides in ground water concern is being addressed?

EPA has proposed a strategy to address the problem of pesticides in ground water that responds to questions like these. There is a need for an Agency plan to help coordinate various EPA program activities and give the States and other federal agencies a clearer sense of EPA's objectives. Many public and private groups gave EPA ideas on what the proposal should contain. When we published the proposal in February, we asked for public comment. The comment period recently ended, and we expect to issue the strategy by the end of 1988.

The goal of the strategy is to prevent unacceptable ground water contamination from pesticides by relying primarily on state pesticide management plans under which the states would identify and deal with the potential for unacceptable contamination and respond with management measures to prevent such an occurrance.

One of EPA's objectives is to strike a proper balance between the national, state, and local roles in defining and preventing unacceptable contamination. The likelihood of ground-water contamination occurring in a particular area depends on local conditions, such as the area's soil types and the depth to ground water; the type, amount, and method of pesticide used; and the specific farming practices being employed, such as irrigation. The perceived unacceptability of ground water contamination depends, in large part, on how that water is being used locally, and its value to the local economy and environment. These factors vary considerably across this nation's vast farming areas.

To properly protect ground-water resources, pesticide management measures will need to reflect a balancing of health protection (including dietary and worker exposure) and economic needs made at state and local levels within overall limits set at the federal level. EPA proposes to allow each state to determine what specific steps to take to protect its own ground water. EPA would intervene in a state decision only if the state decision did not reflect the broad national policy. Should a state choose not to adopt a state management plan, EPA will have to enforce national-scale ground water protection measures that may include cancelling or otherwise limiting the registration of certain pesticides within that state and that necessarily do not reflect state-level decisions about relative priorities. Our recent proposed decision on the pesticide aldicarb reflects this new state-oriented pesticide management approach.

Finally, the Agency is planning to hold a series of workshops around the country this fall to work with state agencies and the public to help foster the development of good state management plans.

CONCLUSION

In conclusion, EPA's goal must be to prevent pesticides from reaching ground water in unacceptable levels. If we find ourselves merely (or even mainly) responding to ground water contamination that has already occurred, we will have failed. Restoration of contaminated aquifers may be technologically or economically impractical, and contamination can persist in ground water for many years. Therefore, we must properly manage pesticide use to prevent unacceptable contamination. This may involve steps such as educating users, providing advice on pesticide labels, requiring changes in application rates, timing, or method, restricting or precluding use of some pesticides in some areas or for some purposes, or cancelling the pesticide's registration entirely. EPA will continue to make risk/benefit decisions under FIFRA. But the states must have the lead role in managing the use of pesticides to assure protection of ground water from unacceptable contamination.

Now, I'd be glad to answer any questions you may have.

Statement by John A. Miranowski
Director, Resources and Technology Division
Economic Research Service
U.S. Department of Agriculture
before the
U.S. House of Representatives
Committee on Public Works and Transportation
Subcommittee on Investigations and Oversight
August 11, 1988

Thank you Mr. Chairman, for the opportunity to discuss with the Subcommittee preliminary findings on the relationships between pesticide use and groundwater quality.

There has been growing concern among farmers, the public, and government officials about the possible presence of pesticide residues in groundwater. This concern focuses on the documented and suspected risks to human and animal health from exposure to groundwater containing certain chemicals. Potentially harmful concentrations of pesticides in groundwater have been found in selected samples from a number of States. However, data relating agricultural activities and groundwater contamination are incomplete, which has hampered the process of identifying the magnitude and nature of the problems and developing a response to the issue.

Since there is no national database on the actual levels of agricultural chemicals in groundwater, any current national analysis is restricted to the conditions that define the possibilities for contamination. In the recent U.S. Department of Agriculture (USDA) study, "The Magnitude and Costs of Groundwater Contamination from Agricultural Chemicals," an attempt was made to use available, but limited data to identify areas with potential for pesticides to leach into groundwater.

This study also developed a general measure of the costs of monitoring private wells for pesticide residues.

To measure the extent of the potential for contamination of groundwater by pesticides, two factors were considered: the vulnerability of groundwater to materials leaching through soils, and the application rates of pesticides to cropland. The vulnerability of groundwater to leaching chemicals was measured by the DRASTIC score. This measure, developed for the U.S. Environmental Protection Agency (EPA), synthesizes seven hydrogeologic factors into a single index, which indicates the potential for pesticides to leach into groundwater. A DRASTIC score was calculated for each county in the 48 contiguous States. A high value for this index indicates that pesticides applied to overlying cropland in that county may have a greater potential to leach into groundwater. Application rates for pesticides, which have a tendency to move to groundwater, were obtained from the USDA and other data sources. Each county in the 48 States was classified according to high, average, or low pesticide application rates.

The data on pesticide applications and the DRASTIC score were combined to obtain a general indication of the potential for groundwater contamination based on a high DRASTIC score, high application rates of pesticides, or both. Over 1,100 of the 3,100 U.S. counties were considered susceptible to pesticides leaching to groundwater based on this procedure. Three hundred and sixty-one counties had both a high DRASTIC score and high pesticide use.

Groundwater resources in areas with potential for contamination provide drinking water to a substantial population, particularly in rural areas. Since the economic costs of human exposure to chemicals in drinking water are very difficult to quantify, an alternative approach was taken which measured the costs associated with avoiding human consumption of contaminated drinking water. These costs were defined as the expenditures necessary to monitor groundwater and detect the presence of pesticides in private wells. The cost of a program to monitor wells in areas identified as potentially vulnerable to groundwater contamination was estimated to be between $900 million and $2.2 billion. This does not include expenditures to acquire water from alternative sources or to treat potentially contaminated water.

The statistics presented in the report serve only as indicators of broad regional and national trends. Yet, some implications can be drawn from this preliminary analysis of the potential for pesticides to leach into groundwater. First, although affecting primarily farming and rural areas, over 40 million people live in areas identified as having the potential for groundwater contamination from pesticide chemicals. Second, the potential for groundwater contamination is not national in scope. Areas of potential contamination appear to be regional, often extending beyond the local or State jurisdictions.

However, the results of this study should be viewed with some caution. The most important point is to distinguish between the concept of potential for, versus actual evidence of, pesticides leaching into groundwater. While the data identify over 1,100 counties as potentially vulnerable to groundwater contamination, it cannot be concluded that wells in these regions are necessarily contaminated with pesticide chemicals. The actual extent of groundwater contamination is currently unknown.

In addition, the data used to measure groundwater vulnerability and pesticide applications are broad, aggregate measures that may mask considerable variation at the local level. Since the available data are based on approximated county-wide averages that do not take into account sub-county variation in the components of the DRASTIC index or pesticide applications, comparisons of potential for groundwater vulnerability on a county-by-county basis are not supportable.

Further, it cannot be assumed that all pesticides found in groundwater come from agricultural activities. Significant quantities of pesticides are used on lawns and golf courses, for mosquito abatement, and other nonagricultural purposes.

Better data and further research are needed to understand the exact nature, scope, and extent of the potential for pesticides to leach into groundwater. The study summarized by USDA's report merely sets the stage for further, more detailed economic and physical analyses of the linkages between agricultural production and unacceptable groundwater contamination. Additional evidence will be available in the future as EPA completes its well water survey. Future economic and policy analyses of strategies to prevent groundwater contamination will depend heavily on the availability and quality of data on the physical processes of groundwater contamination, pesticide use patterns, and local variation in groundwater vulnerability.

Mr. Chairman: This completes my statement. I will be glad to respond to any questions you might have.

Mr. OBERSTAR. We will proceed with our next panel, Dr. Thron, Mr. Buzicky, and Ms. DuBois, after this vote. We will stand in recess for ten minutes.

[Recess.]

Mr. OBERSTAR. The subcommittee will resume its sitting.

[Witnesses sworn.]

Mr. OBERSTAR. Dr. Thron, we would like to begin with you.

TESTIMONY OF DR. RAYMOND W. THRON, DIRECTOR, DIVISION OF ENVIRONMENTAL HEALTH, MINNESOTA DEPARTMENT OF HEALTH; GREG BUZICKY, CHIEF, ENVIRONMENTAL QUALITY SECTION, MINNESOTA DEPARTMENT OF AGRICULTURE; AND MARILYN DuBOIS, DIRECTOR, BUREAU OF PESTICIDE MANAGEMENT, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Dr. THRON. Thank you, Mr. Chairman. I wish to include my written statement into the record and I will then summarize that statement in my oral testimony.

Mr. OBERSTAR. All statements will be received in their entirety for the record, and the witnesses may summarize. Please proceed.

Dr. THRON. As we have heard before, pesticides are indeed used extensively in agricultural crop production. Minnesota is no exception to that. Minnesota farmers were reported to have used pesticides on over 90 percent of their corn, soybean, and sugar beet acreage, nearly 90 percent of their wheat and sunflower acreage, and 60 percent of their small grain acreage.

There are clearly both benefits and risks to these pesticide usages. There has been in Minnesota increasing evidence that certain pesticides are entering ground and surface waters, posing a potential threat to public and private drinking water supplies. In response to some of these earlier concerns and earlier studies that were done by the States of Iowa, Wisconsin, and others, the State of Minnesota has undertaken a number of studies, specifically, the Minnesota Department of Health and the Minnesota Department of Agriculture had initiated cooperative surveys of water wells throughout the State for selected pesticides. These surveys were funded by the Legislative Commission on Minnesota Resources and the United States Environmental Protection Agency and were intended to provide baseline information on the occurrence and extent of agricultural pesticide contamination in the State's ground water and drinking water wells. The report which your committee's staff has, entitled "Pesticides and Ground water: Surveys of Selected Minnesota Wells," is a written report and product of those surveys.

We had sampled approximately 77 counties out of the 87 counties in Minnesota, between July 1985 and June 1987. The types of wells that were sampled between both the Departments of Agriculture and Health included observation wells, irrigation wells, private drinking water wells, tile lines, and some others. The Minnesota Department of Health, with the funding that it received from the U.S Environmental Protection Agency, also conducted some time-series or repetitive samplings where we had taken eight samples per site on 25 private and public drinking water wells.

In general, the surveyed wells were in agricultural regions and within those regions from areas where the local or regional soils and hydrogeologic conditions made the ground water especially susceptible to pesticide contamination. As you are aware, in southeastern Minnesota the karst formations and the karst aquifers and the shallow sand and gravel aquifers overlain by coarse-textured soil were viewed as particularly sensitive and most likely to show evidence of pesticide-related ground water contamination. The karst region in southeastern Minnesota, which also exists in parts of Iowa and Wisconsin, is generally characterized by shallow depths to porous and permeable carbonate bedrock and in some areas by features such as sink holes, caves, and disappearing streams. These conditions clearly can result in a rapid transport of surface water containing dissolved or soil-bound pesticides into the ground water. It was important that we closely look at these areas.

We have enumerated in the surveys a number of well-selection criteria. Some wells were selected to provide an overall coverage of the State's agricultural regions and diverse cropping patterns. The Minnesota Department of Health also selected several public drinking water wells, based on historically high or fluctuating nitrate levels, or on the well's proximity to bulk pesticide storage and handling facilities.

Let me now get into the analysis and the results of some of these surveys. The results of the surveys indicated that several pesticides were present in ground water and drinking water wells, especially in the hydrogeologically sensitive areas of the State. The analytical results are presented for you in Tables 2 through 6, and Figures 2 through 8 of the previously mentioned report and also in the attached paper which I have submitted as a part of my testimony. In summary of those results, one or more pesticides were detected in 39 percent of the wells that were sampled in the State. Sixteen pesticides, including fourteen herbicides, one insecticide, and one wood preservative were detected in these surveys. Atrazine, a pesticide which is commonly used in corn production, was found in 37 percent of the wells, and it was the most commonly detected pesticide in the survey phase. Alachlor and 2,4-D were the next most frequently occurring pesticides. Each of the remaining 13 pesticides were detected in nine or fewer wells. Multiple pesticides were present in 55 wells.

I have mentioned the various chemical pesticides and I wanted to also comment for you on the issue of nitrate/nitrogen findings in Minnesota as well. I think that during the past years, much of the emphasis on ground-water and drinking water monitoring has focused on nitrate and nitrogen, and that has been because of the known public health effects that can occur with excessive levels of nitrate/nitrogen, particularly for infants under six months of age. So we did also, as a part of these pesticide surveys, sample and analyze for nitrate/nitrogen. We did find detectable amounts of nitrate/nitrogen in 47 percent of the wells sampled, and in seven percent of those wells, the levels exceeded safe drinking-water levels.

Although the percentage of wells with detectable levels of pesticides was relatively high, the concentrations detected were usually low. Eighty-three percent of all the pesticide occurrences were at concentrations less than 1.0 microgram per liter. Levels exceeding the State Health Department's drinking-water limits were observed in samples selected from 16 drinking-water wells. These included five public wells and 11 private wells. Pesticides were detected in 51 of the 77 counties sampled, but were for the most part, commonly found in wells completed in karst formations in southeastern Minnesota, the shallow out-wash sand and gravel aquifers in central Minnesota, and the shallow alluvial sand and gravel aquifers in southwestern Minnesota. Few pesticide occurrences were observed in northwestern and south central Minnesota.

I think that these numbers tell us one important thing and indicate some direction that we ought to take. First, there is concern about the high percentage of detectable amounts of pesticides, as I mentioned earlier, 39 percent. I think that clearly raises the flag and is indicative to us that we must continue monitoring to ascertain what the trend is regarding the pesticide concentrations. Fortunately, the levels in most of those are low. It is only in 16 wells that we found an exceeding of the recommended action level that the State Health Department had developed.

One other comment I would like to make regarding wells concerns the well construction itself. Often when we look at pesticide contamination and find it in drinking-water supplies, we overlook the fact that the well that is being used may be an old well, an abandoned well, or a deteriorated well, and we have clear evidence in work that we have done in the State's drinking-water program that a deteriorated well with casings that are broken can very easily allow the introduction of pesticides into the well casing and then transfer it down into the underground aquifer. We have video taping of such occurrences where we have lowered a camera designed specifically for in-the-hole well monitoring, and have pictures of water entering well casings.

Minnesota has been active in addressing the issue of ground water contamination by pesticides and in developing policy and management strategy to assure long-term, water quality protection.

Briefly, two management strategies are currently under preparation by the leadership of the Minnesota Environmental Quality Board. One strategy involves the writing of a Minnesota Groundwater Protection Strategy and the other involves the writing of a Pesticide in Nutrient Management Strategy. A standing committee of the Water Resources Committee of the Minnesota Environmental Quality Board is overseeing this effort. That committee is comprised of several State agencies, the University of Minnesota, and some citizen members. It is this collection of Minnesota agencies, departments, and institutions which will hopefully result in a diversity of expertise, perspective, and opinion, and will put together two good strategies for the State.

The ground water protection strategy which likely will be adopted by the Environmental Quality Board on August 18, 1988, will serve as a blueprint for future ground water management activities at the State level, and will also help to define the local role in ground water management protection. The strategy is really built on the strong regulatory and educational framework which already exists in the State. State agencies already have the statutory authority to establish ground water standards, to regulate pollution sources, to protect and monitor drinking water supplies, to regulate appropriation of ground water supplies, and to regulate the sale and use of agricultural chemicals which may impact ground water quality. More detail is provided in my written testimony.

The Pesticide and Nutrient Management Strategy builds upon the framework established in the Minnesota Groundwater Protection Strategy. Basic initiatives and tenets under consideration in the Pesticide Management Strategy include the following: fostering an integrated approach to pesticide management which includes education, research, monitoring, incentives, regulation and coordination; striving for modifications in individual behavior; emphasizing land stewardship; prevention, to be the cornerstone of the management strategy; nondegradation as the goal; degradation, where it is sustained and ongoing, should be met with action; and actions that are implemented should be geared toward environmental and health protection. It is not the marginal exceeding of a standard that is the problem. It is the continued long-term exceeding that raises the public health concerns and results in problems with meeting standards for drinking-water supplies.

Regarding Federal Governmental roles, we feel that it is important that Federal agencies, particularly the United States Environmental Protection Agency, continue in active involvement in developing pesticide in ground water management strategies. There is need for support for monitoring programs, support for basic and applied research, and a need to act as a facilitating agent. Most important is the need at the Federal level to take the leadership regarding basic and applied research and to coordinate those efforts. Of particular importance are continued research into the health effects of chronic low-dose exposures to pesticides in drinking-water supplies, perhaps looking at further research into the nitrate and nitrosamine linkage to the development of gastric cancers, the development and improvement upon analytical methods and techniques for measuring methods, investigations into the breakdown products of pesticides, some of which may be more toxic than their parent compounds, and continued research into the transport and fate of pesticides in the soil, water, and air environments.

Last week, I visited the U.S. Environmental Protection Research Laboratory in Duluth, and the research scientists there indicated to me that the volatization of pesticides into air contaminants and the redeposition elsewhere into surface water clearly needs attention. I think that indeed could be a significant nonpoint source of pesticide contamination. We also support Congressional passage of ground water management strategy which will hopefully provide a framework of Federal policy, and we hope that the respective roles of Federal agencies in partnership with States would be clearly elaborated.

In summary, pesticides have been detected in Minnesota's ground water and drinking water in the hydrogeologically sensitive areas of the State. Although the percentage of wells with detectable levels was high, the concentrations were low. The widespread occurrence of pesticides, particularly atrazine at low concentrations in certain areas, and the presence of pesticides in observation wells near field application sites, indicate that ground water contamination may result from normal pesticide use as well as from point sources and nonpoint sources of contamination.

While pesticides were observed more frequently in wells in certain areas of the State, the potential for contamination in a specific well is indeed influenced by a complex set of factors, which include the source, the chemical properties of the contaminant, well construction, local ground water vulnerability, and local agricultural practices. These factors can vary considerably from area to area, as well as from well to well. Nevertheless, the occurrence of certain pesticides in ground water, the unknown human health implications resulting from exposure to low levels of pesticides in drinking water, and the many unresolved questions relating to the complex movement and fate of pesticides in the environment raise significant questions which must be answered.

Mr. Chairman, that concludes my summary remarks, and I will be happy to respond to questioning.

Mr. **Oberstar**. Thank you very much for a very comprehensive and very detailed statement which I find very helpful for the purpose of our hearing. I also think that you should have felt very good about the compliment paid by our EPA witness at the outset of her testimony. It was a compliment to the State of Minnesota and to your agency.

Ms. DuBois.

Ms. **DuBois**. Thank you, Mr. Chairman. It is a pleasure to be here today.

My name is Marilyn DuBois, and I am the Director of Pesticide Management for the New York State Department of Environmental Conservation.

The Department of Environmental Conservation has the lead responsibility in New York for both pesticide regulations and protection and management of ground water resources. In support of our responsibilities, the New York State Department of Health provides toxicology assessments and is responsible for community water supplies. The New York State Department of Agriculture and Markets represents the agricultural community, many of whom are pesticide users.

The Department has developed two programs for the comprehensive management of ground water resources, the Long Island Groundwater Management Program and the Upstate New York Groundwater Management Program. I brought copies of those two strategies for the committee, and I will leave them for your review.

Mr. **Oberstar**. Thank you very much. We will receive that for the subcommittee file.

Ms. **DuBois**. These two programs provide a systematic approach for protection of ground water and prevention of contamination involving all levels of government. These programs are periodically updated to determine the level of implementation for the recommended strategies.

The Department also has promulgated regulations which classify all fresh ground water to be protected as potable and applies the same ambient water quality standards and criteria for ground water protection, whether the ground water is a current or potential drinking water supply.

As major point sources of pollution are being brought under control, the Department has also developed a Non-point Source Management Strategy, identifying agricultural and urban storm water runoff as high priority nonpoint source program needs. The Department is now creating a nonpoint source management program group to deal with the implementation of this strategy.

There are areas of the State, such as Long Island, where more extensive ground water monitoring and regulatory activities occur, due to the high vulnerability of the ground water which serves as the sole source of drinking water for millions of persons. Since the mid-seventies, about 90 of approximately 1,000 major public drinking water wells on Long Island have been closed or restricted in use because of contamination from synthetic organic chemicals and nitrates. Private household drinking water wells have also been contaminated by synthetic organics, pesticides, petroleum products and nitrates. For example, contamination to eastern Suffolk County wells with aldicarb [Temik) have led to the installation of activated carbon treatment units on over 1,400 private household drinking water wells. There is currently concern with dachtol contamination in drinking water wells which may lead to additional regulatory action.

In upstate New York, 18 major aquifers serve as drinking water supplies for almost one million people. The ground water quality of most areas in upstate New York appears to be good. However, there is increasing evidence of significant ground water contamination problems. The most significant upstate ground water quality problem is organic chemical contamination. Thirty-three upstate public water supply wells have been closed due to organic chemical contamination; some have subsequently reopened. Petroleum products are the most commonly reported type of organic contamination of private household wells, and also cause public well closure. Pesticides have caused extensive ground water contamination on Long Island and could also be a threat to upstate areas. High nitrate levels which are related to agricultural and domestic fertilizer use have been found in upstate wells.

Pesticide monitoring in the upstate area occurs on a limited basis. As a condition of the Department's 1986 emergency regulation allowing aldicarb use on potatoes in upstate New York, Rhone-Poulanc, the manufacturer, was required to conduct limited sampling of domestic wells on farms where aldicarb was used and also on a small test plot. I should mention that aldicarb is only allowed for ornamental use in upstate New York and it is completely prohibited from use on Long Island. So there is very limited aldicarb use currently in New York. The monitoring that was done on the wells as part of the 1986 decision to allow the use on potatoes was conducted by Cornell University Water Resources Institute and they have prepared a draft report on the results. I do not have a copy of the final report. When I can get it I will be happy to make that available to you. In addition, the small field-plot well monitoring continues to this day, and aldicarb residues continue to be found in a number of the special monitoring wells.

Another special pesticide monitoring project resulting from the Upstate New York Groundwater Management Program, was conducted in upstate New York by the Cornell Water Resources Institute in conjunction with the Department. This monitoring was done between July, 1985 and December, 1987. There were 148 samples collected and analyzed for alachlor, atrazine, carbofuran and its metabolite 3-OH carbofuran, carbaryl, cyanizine, metalachlor and simazine. That final report is being prepared at this time, and we expect to have it issued in the next few months. If you are interested, I can make that available to you.

Mr. OBERSTAR. Please do, we would like to have that information.

Ms. DUBOIS. On a much smaller scale, the Bureau of Pesticides has been working in at least one county to try to correlate pesticide use with ground water contamination, working with individual farmers and finding out what pesticides they have used, and planning to use existing wells, and if necessary, some additional special monitoring wells to see if we can begin to correlate data in a county where we know we have high vulnerability to contamination from agricultural chemicals and where we know where they are being used.

The Federal Groundwater Strategy is certainly a program that is very difficult to design and implement since it is hopefully going to be a prevention-based ground water program. The strategy as proposed by EPA in its "Agricultural Chemicals in Groundwater: Proposed Pesticide Strategy," presents many problems. I have a copy of the letter which our agency sent to Dr. Moore commenting on that strategy, and I will include it with the materials that I provide to the subcommittee because I think it provides a good overview of some of the kinds of concerns that we have about their approach to ground water management. As was discussed earlier in this morning's hearing, EPA proposes a vulnerability-based pesticide management scheme which would be implemented by usage bands and decreased or modified usage.

[Copy of letter referred to follows:]

STATE OF NEW YORK
DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK 12233-1010

THOMAS C. JORLING
COMMISSIONER

JUN 28 1988

Dear Mr. Moore:

The comments of the New York State Department of Environmental Conservation on the "Agricultural Chemicals in Groundwater: Proposed Pesticide Strategy" are enclosed.

Our Department has the lead responsibility in New York for both pesticide regulation and protection and management of groundwater resources. The implications of the proposed strategy are most directly relevant to our programs. The NYS Department of Health provides support to our Department through toxicology assessment and is responsible for community water supplies. The NYS Department of Agriculture and Markets represents the agricultural community and many pesticide users.

New York State has had extensive experience with pesticide control for groundwater protection, and we appreciate the difficulties in designing and implementing a prevention-based program. The strategy suggested in the subject document presents many problems. First, a method which can accurately predict pesticide contamination potential in real field conditions is not available. The resources necessary to perform even generalized vulnerability assessments are enormous and may disorient our priorities for other groundwater assessment efforts. DRASTIC is a method subject to much dispute, and many supporting data are not available. Finally, and perhaps most importantly, pesticide regulation and enforcement are, at this time, not achievable at a county-by-county or sub-county level in Upstate New York. We have had success with this approach for Long Island counties, but do not consider it realistic in the rest of the State due to the nature of pesticide distribution and marketing, the current pesticide label system, and the available resources for pesticide-related education, use recommendations and regulatory enforcement.

Despite these reservations, we see a strong need for groundwater protection with respect to agricultural chemicals. Rather than support significant decentralization of pesticide control, we support a stronger, more centralized effort at the national level. The national program, while it should recognize variations in vulnerability, should not result in unequal impacts on the agricultural economy of different states. Such unequal impacts are much more likely with the decentralized approach suggested in the strategy. We also support a much stronger federal commitment to integrated pest management and stronger efforts to recommend alternative pest control methods, alternative chemicals and lower application rates. Finally, the issue of nitrogen fertilizers must be addressed because nitrates are a principal contaminant in rural areas.

The groundwater protection criteria are the foundation of any prevention-oriented program. We do not generally support universal use of drinking water maximum contaminant levels as the "trigger" criteria for beginning groundwater protection efforts. Lower levels often are preferred.

The enclosed comments represent our position in response to the proposed strategy, which leaves many unresolved issues. We anticipate further development of this strategy and look forward to working with EPA toward the goal of groundwater protection in agricultural areas.

Sincerely,

Thomas C. Jorling

Thomas C. Jorling

Enclosures

Mr. John A. Moore
Assistant Administrator for
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U.S. Environmental Protection Agency
401 M Street, S.W. (TS-788)
Washington, DC 20460

bcc: Commissioner Jorling's File
  Mr. Marsh
  Dr. Banks
  Mr. Cross
  Mr. Kaul
  Ms. Dubois
  Mr. Barolo
  Mr. Pagano
  Mr. Roberts
KR:bjc

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
COMMENTS ON
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AGRICULTURAL CHEMICALS IN GROUNDWATER:
PROPOSED PESTICIDE STRATEGY

The Department of Environmental Conservation is pleased to note the effort and consideration taken by the Environmental Protection Agency in developing a proposed strategy for pesticides in groundwater. We recognize the difficulties faced in establishing and implementing such a strategy. Our own experience with pesticide contamination of groundwater and with establishing a comprehensive groundwater management and protection strategy gives us an appreciation of many of the complicated issues involved in managing pesticides and groundwater.

These comments of the Department of Environmental Conservation are organized as follows:

I. SUMMARY OF MAJOR CONCERNS

General comments on the broad structure of the strategy, particularly the vulnerability mapping.

II. KEY ISSUES

Comments on the "Key Issues" questions on pages 2 and 3 of "To The Reader" in the strategy.

III. ADDITIONAL COMMENTS

Additional comments on the body of the strategy report.

A major difficulty that will be shared by many who wish to comment on important questions posed in the strategy is that the document is far from complete. In the last 15 pages, there are nearly 100 significant questions which have major bearing on the shape of the strategy. These are largely unanswered in the document, even in proposal format. To answer these and the many other questions and concerns in the rest of the document would require a state to develop a draft at least as long as the document itself. Our comments are substantial, but we must leave many questions unanswered. We encourage EPA to draft a more complete proposal and provide time for a more complete response.

I. SUMMARY OF MAJOR CONCERNS

New York strongly supports the general concept of pesticide management to prevent groundwater contamination and agrees with the goal of protection of current and potential drinking water sources for best use as potable water. We also generally agree with geographic targeting concepts. But many problems are raised by the framework suggested in the strategy. The strategy is, perhaps intentionally, not specific in its suggestions and many important issues are left open for interpretation.

The concerns stressed in these remarks are based on our interpretation, strengthened by meetings and discussions with EPA officials, that EPA intends to shift the most significant burden of pesticide management to states and require states to complete pesticide contamination vulnerability assessments and mapping and directly tie pesticide controls to that assessment. EPA also suggests that states map different levels of groundwater resource potential as future drinking water sources for direct application to pesticide controls. If states do not adopt these approaches, EPA holds out the threat to ban pesticides of general concern statewide.

The baseline strategy, as stated on pgs. 103 through 106, suggests that, in the absence of a similar State effort, EPA will score individual counties and propose pesticide controls that range from use moratoriums or bans to required farmer interpretations of prevention measures and local groundwater vulnerability. We do not support the user-based concept. It is both a significant burden to farmers, and assigns the decision to individuals that may not have the training or deeper soil and aquifer information to make well-founded interpretations.

While on one hand EPA acknowledges that county-level vulnerability scoring is not valid for pesticide regulation (pg. 36) and that "there is still a great deal of uncertainty in identifying the exact locations of areas vulnerable to contamination" (pg. 113), EPA's proposed strategy states that vulnerabilities must, at a minimum, be scored on a county-wide basis and pesticide regulation will be based on this assessment.

The responsibility and methodology for this mapping are vague. In a meeting with EPA (Cornell; May 2, 1988), it was suggested that the DRASTIC model will be employed. We have very serious concerns with this approach. We do not believe that the DRASTIC model is suitable for county-based pesticide control (or for sub-county-based control), nor do we believe the supporting data for DRASTIC calculations are generally available (depth to water table, net recharge, vadose zone properties, etc.) with detail adequate for mapping or appropriate for enforcement.

A significant concern with the vulnerability map-based pesticide control strategy is not the geographic targeting concept, which we generally endorse. Rather, it is the overly strong front end emphasis on this element of pesticide management. There is no balanced development of other aspects of pesticide control, from integrated pest management to pesticide application inspection. The strategy goes beyond suggesting county-wide vulnerability scores (which make very little sense in New York) to suggest that states provide pesticide users with maps that clearly delineate highly specified areas and clear instructions for these areas on whether or not to use a pesticide or to use it in a certain manner. We do not believe that the authors of the pesticide strategy have a clear understanding of the scope of such a task, even if a sub-county resolution is attempted rather than field resolution. We also do not believe that this objective was weighed by the authors with respect to other groundwater protection activities in states and other hydrogeologic data collection and interpretation priorities. We are not convinced that there has been sufficient groundwater monitoring evidence to show a correlation between observed contamination and DRASTIC or DRASTIC-type vulnerability scores that is strong enough to warrant such a major commitment of staff resources at the expense of other program activities.

The implementation of a vulnerability-based pesticide management scheme may go in two directions for selected priority pesticides. The first is usage bans and the second is decreased or modified usage. EPA directly acknowledges the difficulty or impracticality of implementing and enforcing usage bans on an acre-by-acre or sub-county resolution (and even county by county resolution in some cases). The greatest potential for progress will likely be in reducing or modifying usage (integrated pest management, rotational use, alternative pesticides, decreased rates, later or fewer applications, altered application methods). Rather than investing very significant resources in up front vulnerability mapping only to sometime later face the issue of modified usage or alternative control recommendations, we believe the strategy should place its greatest emphasis on the integrated pest management, education and outreach issues first. We can make useful advances now and not spend disproportionate effort deciding whether to reach out to a farmer on one side or the other of a high-medium or medium-low, theoretical vulnerability boundary. We believe EPA should make major commitments in this area.

There must be a stronger effort to put reduced, modified or alternative control recommendations in black-and-white and get the message to users. Many state pesticide regulators do not have the staff depth or breadth to accomplish this and EPA should emphasize program development in this area in technology transfer, grants to states, and work with land grant institutions, cooperative extension and other agencies. Those who can make the greatest contribution are experts in pest control, crop management and pesticide and groundwater chemistry. We would agree that overall responsibility for this effort is shared at many levels, but there is a critical need for strong federal support in this direction. If, for example, an alternative pesticide is considered less threatening to groundwater than another (with respect to mobility, persistence or toxicity), then it is the government's responsibility to clearly state that and develop recommendations. If such recommendations conclude that one commercial product is less threatening than another, it is time for government to publicize that and end its avoidance of comparing commercial products. With all of the work farmers must do, we cannot expect them to perform such complex analyses and assess groundwater threats.

There are significant problems in implementing a county-based vulnerability assessment and pesticide control program in New York State. Although there are distinctly different geologic regions in New York, nearly all of the Upstate agricultural counties (virtually the entire state, excluding the Adirondack and Catskill mountains) contain a heterogeneous distribution of higher and lower vulnerability areas. Although there is some variation, the counties are roughly similar in this regard. Although surficial aquifers are a useful yardstick measure of vulnerability, they may not be appropriate as direct indicators of high pesticide vulnerability because many confining layers are present and depth to groundwater varies significantly. The general heterogeneous nature of most Upstate counties suggests that no group of counties clearly stand out above other counties as warranting restriction. It is noted that we dispute the county-level DRASTIC scoring for New York State illustrated on page 37 of the strategy. The predominant agricultural soils in nearly all of the counties scored by EPA as high vulnerability are derived from lower permeability glacial tills and lacustrine silts and clays. The basis for EPA's designation is unclear, but we consider these areas to have lower vulnerability though some high vulnerability areas are included. EPA should not base its federal control program on the map presented on pg. 37. Additional comments on the DRASTIC method are provided later in this submittal.

The more important concern, though, is that we do not consider county-by-county pesticide control restrictions to be practical or enforceable in Upstate New York. We have had success with this on Long Island because of its geographic isolation from the rest of the state and chemical distributors, and because the crop and pest problems were distinctive. The nature of pesticide distribution and marketing can make county-based or sub-county controls in Upstate New York nearly unenforceable. Considering the trend to pesticide label simplification and improvement, the means for implementing county-level controls becomes more complicated.

States are presently forbidden from requiring any label additions or changes. Unless EPA designs a label system whereby county-level controls are reflected in the labelling, there will be no functional system to inform users of their obligation in a county-based system. A county- or sub-county-based pesticide control approach will require very significant increases in staff, both in the educational and advisory sector and in the regulatory and enforcement sector. A cursory evaluation suggests that approximately 120 new pesticide control professionals may be required in New York State for regulatory aspects alone (from the current 35). This does not include needs in educational outreach, pesticide usage inventory or groundwater vulnerability assessment, which may pose similar demands.

It appears that, through this strategy, EPA is shunting the predominant burden of managing pesticides for groundwater protection to states while offering the states little more than federal Maximum Contaminant Levels (MCLs), generalized pesticide information and the threat that EPA may cancel registrations of pesticides within an entire state if it does not follow the strategy notions of vulnerability-based county or sub-county pesticide controls. There is no hint whatsoever of any funding to be provided to states for these activities. There are many presumptions in the strategy document that certain categories of data are readily available to states (e.g., detailed site-specific pesticide usage records, hydrogeologic data) which generally are not. There is a presumption that states can afford and will implement anticipatory or wide scale ambient monitoring for pesticides in groundwater. But there is little perspective on costs or how this makes sense in light of the full range of groundwater issues facing states. Funds that would be expended in a broad, routine ambient monitoring program may be much more productively spent on direct development of integrated pest management. Some form of monitoring is needed, but it should be in balance with those needs and other groundwater issues not related to pesticides. A similarly balanced perspective should be applied to the vulnerability assessment and geographic targeting effort.

Federal responsibility should not be limited to imposing national bans on a few pesticides, providing MCLs for others and then requiring a broad vulnerability assessment effort by states with little other real, useful support. While New York, as any state, supports the primacy of states in managing their resources, we see a need for stronger federal leadership and a stronger commitment to alternative approaches to reducing the groundwater impacts of pesticides of concern than is shown in this strategy.

II. KEY ISSUES

The following comments specifically address the key issue questions posed on pages 2 and 3 of "To The Reader" in the strategy.

1. Health Risk Assessment and Pesticide Management

a. Reference Points

The question suggests that there are two issues. First, is the Safe Drinking Water Act Federal Maximum Contaminant Level (MCL), when available, the appropriate reference point or criterion for setting the groundwater resource protection goal? Second, when the MCL is not established, is it appropriate to use an interim reference point and what should that reference point be?

An important underlying issue is how "reference points" or criteria are applied in groundwater management. They may be applied in setting groundwater protection goals and making pesticide control decisions for this purpose. They may also be applied in setting groundwater contamination response goals or setting finished drinking water quality goals. New York State does not believe that it is necessary that the same reference point criterion apply for all categories of management applications. New York State employs ambient groundwater quality standards and guidelines for designing its groundwater protection programs, and these are sometimes more restrictive than our drinking water standards. Certain protection actions may be appropriate prior to an MCL violation in the resource.

b. Current and Potential Drinking Water Sources

We agree with the general strategy position that potential drinking water sources should be afforded the same level of protective management as current sources. New York State classifies all fresh groundwaters as potentially potable and applies the same ambient water quality standards and criteria for groundwater protection programs whether the groundwater is a current or potential drinking water source.

The most important underlying issue is the definition of potential drinking water sources and differential potentials. The strategy implementation discussion on pages 135 to 136 suggests that areas remote from human dwellings or outside of rapid population growth may be classified as "low potential" and that less stringent protection policies be applied. This is obviously a difficult issue, but the EPA strategy suggestion is just as difficult. Most agricultural areas are not in "rapid population growth" or even significant population growth locations. But there is a very distinct trend to spotty and unpredictable building of homes, singly or in clusters, in these areas. Low potential areas can unpredictably become high potential areas with the simple decision of a landowner to retire, to sell a portion of his land, or to build a home for a family member. The strategy suggests that employing differential potential concepts will then require classifying areas of the state by these potentials. This would be an overwhelming task and is probably not that meaningful, especially at the local scale that is really necessary.

2. Roles and Responsibilities of EPA and the States

a. Risk-Benefit Analysis and Differential Protection

States should have the authority to employ more restrictive criteria than federal levels in implementing protection efforts. States should have the authority to determine the need for cleanup of pesticide contaminated plumes and establish related criteria and policy. The Federal protection strategy should not adopt geographic targets for higher level protection that are delineated for other purposes and are delineated differently in different states, such as the Wellhead Protection Areas (WHPA).

Wellhead protection areas are multi-purpose planning and groundwater management tools delineated for varying objectives in different states. Policies have not been finalized in most states. In some states, WHPA's may be a somewhat arbitrary fixed radius area around a well (from 1,000 feet to 5 miles), while some states may extend WHPA's to significant portions or even complete aquifers. EPA should not implement a uniform national policy for pesticide control within WHPA's due to these differences. States and local government should determine policy regarding higher levels of protection within WHPA's and other special groundwater areas.

Similarly, EPA should not tie its pesticide control strategy directly to the recommended federal groundwater classification scheme. States, like New York, which developed suitable groundwater classifications prior to EPA may not find this scheme workable.

Vulnerability assessment is a major issue, and states should have authority to determine the need to employ this approach and appropriate methods. The EPA strategy appears to assume that it is reasonable to use a scheme comparable to DRASTIC at the county, sub-county or local level, and that states would perform such vulnerability assessments for agricultural areas (in many cases, large portions of the state). In the first place, the current vulnerability assessment methods are questionable with respect to pesticides, and they require major staff commitments. Secondly, reasonably reliable data are not generally available to implement such schemes. We believe there may be greater benefit adding pesticide inspectors, applicator trainers, integrated pest management experts, pesticide chemists and toxicologists, and other staff that may directly contribute to pesticide management.

We do not reject the concept of geographic targeting, but request that other aspects of pesticide control be developed in balance with the assessment and planning stages. The assessment stage itself depends in large part on having more accurate and detailed inventories of pesticide usage. The strategy appears to presume that these are available or can be readily developed by states. For the site-specific geographic targeting approach employed in the strategy, great detail is needed. States generally do not have this level of detail, and such an inventory is a major undertaking. The Federal government should provide assistance in developing these inventories. States do not have consistent formats and the information is extremely variable in time, accuracy, completeness and geographic detail. EPA should assist in designing inventory formats useful in strategy implementation and other pesticide management programs, in writing the software and in providing grants for implementation. Some uniformity in the inventories among states would be a great boon to implementing a national strategy.

b. EPA Oversight of States Programs

States should retain the authority to be more restrictive than federal controls on pesticide usage. If a state is negligent in its pesticide regulation, EPA should have the authority to cancel or modify a pesticide registration in that state. This EPA oversight, though, must be based on legitimate, specific environmental concerns and not be based on punitive grounds against states which choose not to follow EPA's management strategy approach. Therefore, such cancellations or modifications by EPA would be expected to be implemented in all states where similar contamination potential exists.

c. Chemical-Specific and Generic Plans

Chemical-specific plans should be developed for significant high priority pesticides (high usage, mobility, persistence, or significant toxicity). To the extent possible, chemical-specific plans should be considered for other pesticides designated as known or potential groundwater contaminants. Generic plans should be developed first if major delays are anticipated.

Generic plans have great value in two regards. They may encompass pesticides that would not otherwise be included or which would not be specifically addressed for long periods. They may also be more useful for integrated pest management issues that require use of multiple chemical approaches. Generic plans may be designed to address a particular problem (e.g., weed control in field corn) and consider the variety of chemicals and crop management tools used to control the problem. These benefits may not be as strong if there is exclusive reliance on discrete chemical-specific plans. Therefore, we recommend that generic plans oriented to integrated pest management be developed.

III. ADDITIONAL COMMENTS

A. Problem Assessment Summary

While we do not consider revision of the Problem Assessment Summary essential for formulating a final strategy, we do generally agree with the conclusion on page 47 that "understanding (the factors affecting pesticide contamination of groundwater) is essential for designing an effective prevention strategy." Therefore, either in this section of the strategy or in a separate publication, we suggest the following:

1. Complete a more accurate and thorough national summary of known pesticide contamination. Within this report, the text on page 22 and Table I-3 and Figure I-4 are in disagreement. The "typical positive" level is useful, but a range would also be useful. A summary comparing known detection levels and ranges with proposed health advisory guidelines, MCL's and other criteria would be very useful. The summary should include appropriate detections of pesticides used for non-agricultural purposes, if any, because they are part of the same management and regulatory system. The summary should separately review pesticides known to cause contamination as a result of spills, disposal or other non-application sources, because those cases are still part of the pesticides in groundwater issue and can serve as potential indicators of pesticides of concern when used normally. Create a newsletter to update this summary.

2. The "Causative Factors" discussion should be improved, though this may be better accomplished and more useful in a separate document from the strategy. This dis-

cussion on pages 29 to 39 does not mention one of the most important factors: soil stratification or the changes with depth in properties that control pesticide migration. Soil acidity is also not mentioned. Hydraulic properties of soils should be better addressed.

3. The problem assessment summary does not address the issue of pesticide usage inventories and data management systems that can make such information retrievable and useful to EPA and the states.

B. Proposed Pesticides Strategy

1. The differential management approach described on page 103 will require (in "some" cases) that the pesticide user determine prevention measures based on interpreting local field conditions. While it is often reasonable to assume that a farmer knows his land, this dependency on pesticide user interpretations can have significant drawbacks, as follows:

   a. Interpreting environmental factors affecting pesticide migration can be very different from those related to crop productivity or trafficability, which the farmer knows best. This is especially important with depth.

   b. The user or applicator is often not the person with intimate knowledge of the site.

   c. This approach has been tried before, and guidelines to the user are often ambiguous and complicate his job to the point where it may not be effective.

2. Vulnerability at a specific location can change significantly if the land is converted from conventional tillage to conservation or no-tillage, though the degree of vulnerability change is difficult to predict. How can this be placed on a simple map?

   Other environmental factors and aspects of land and crop management which are not easily mapped will also affect vulnerability (e.g., irrigation).

3. On page 114, it is stated that "the registrant may also be required to do site-specific monitoring in an area where contamination has already occurred, if the registrant desires to continue registration of the pesticide in that area ...".

   The responsibility of the registrant should not end if the registration is withdrawn. The registrant may find it cheaper to withdraw the product than resolve the contamination problem. States must be permitted to require continued monitoring in addition to other response actions by the registrant.

4. The hydrogeologic data priorities for New York are to complete aquifer mapping and gather more fundamental aquifer property data for multi-purpose objectives. We cannot disorient this work by developing DRASTIC-type maps or scores for all agricultural areas (56 counties or 10,000,000 acres). The DRASTIC maps would not even have applicability to other programs, as the weighting factors are different for agricultural vulnerability scoring.

There are serious limitations in attempting to apply DRASTIC or related schemes to large areas due to very limited availability of supporting data or of reliable data (especially with depth). Some of these limitations follow:

a. Depth to Water Table (D):

Map data not sufficiently available for large areas of the state at 5 foot contour intervals.

b. Net Recharge through Vadose Zone (R):

Map data not available in 2-inch intervals or other intervals.

c. Soil Media (S):

The soil media ratings in DRASTIC are too generalized when applied at county or sub-county levels, and do not recognize significant near surface variability or organic matter influences when applied at a site-specific level.

d. Impact of Vadose Zone (I):

Map information is not available and the scoring method is too subjective with respect to interstratified deposits.

e. Hydraulic Conductivity (C):

Map information not widely available.

The problem, in essence, is that county-level vulnerability scores for county-level pesticide control have little meaning due to significant geologic variability within New York counties. Sub-county scores have nearly the same problems with significantly higher labor requirements. Site-specific scores might be more useful, but they would be virtually impossible to calculate for large areas and have questionable value since there has been no positive demonstration that DRASTIC scores correlate strongly with observed pesticide contamination. Enforcement of pesticide controls at this level would be extremely difficult.

Ms. DuBois. The Department believes that rather than investing very significant resources of financial commitment and staff up front in a vulnerability mapping program only to find sometime later that the issue of modified usage or alternative control recommendations are necessary, that the greater emphasis should be placed on looking at nonchemical alternatives, integrated pest management, and education and outreach to pesticide users. There must be a much stronger effort put on reduced, modified, or alternative control recommendations, and we must get this information to pesticide users now.

The Department feels that there are also serious flaws in the EPA DRASTIC model which has been developed to protect ground water vulnerability. In New York State there are distinctly different geological regions, which include virtually all of the State excluding the Adirondack and Catskill Mountains, which contain a very heterogeneous distribution of higher and lower vulnerability areas. Therefore, no group of counties clearly stands out above others as warranting restriction of pesticide use. County-by-county pesticide restrictions are both impractical and unenforceable.

It appears that EPA is placing the predominant burden of managing pesticides for ground water protection on the States, while offering the States little more than maximum contaminant levels, generalized pesticide information, and the threat that EPA may cancel registration of pesticides within an entire State if it does not follow the strategy notions of vulnerability-based county or subcounty pesticide controls.

The proposed strategy on aldicarb is an example of a very complicated strategy for States to prepare management plans and New York is one of those States. This is a precursor of strategies that EPA would use for each chemical which it identifies as a leacher, and as you heard this morning, they have at least 50 high priority and over 100 chemicals that fall into that category, which would present a highly complicated regulatory scheme for any State having to deal with that multiplicity of chemicals and the varying restrictions on counties where they might be used or prohibited from use.

EPA must exert its regulatory authority to deal with the issue of pesticides known to leach to ground water by developing consistent national strategy. The program as proposed will lead to unequal impacts on the agricultural economics of different States. There must be a stronger commitment to integrated pest management and stronger efforts to recommend alternative nonchemical pest control methods, alternative chemicals, and lower application rates. The issue of nitrogen fertilizers must be addressed, as these are principal contaminants in rural areas. Ground water protection criteria are the foundation of any prevention-oriented program. Action levels lower than the MCLS are necessary for adequate ground water protection. The Department has not formally developed its recommendations for alternatives to the EPA strategy. Nevertheless, we do not support the policy to allow continued contamination of ground water. Finally, EPA can not expect the States to carry out these responsibilities without additional funding to support these programs.

Thank you for the opportunity to come here today. I would be glad to answer any questions.

Mr. **Oberstar.** Thank you very much. That was a very thorough and detailed analysis of the situation in New York State. We appreciate your contribution.

Mr. Buzicky.

Mr. **Buzicky.** Thank you, Mr. Chairman and members of the subcommittee, for the opportunity to provide testimony on the impact of ground-water contamination by pesticides on farmers, agribusiness, and the Minnesota Department of Agriculture's policies. My remarks will follow directly from those of Dr. Thron's and I will talk about the effects of the release of pesticide surveys that were conducted jointly by the Department of Agriculture and the Department of Health during the period from 1985 to 1987.

Prior to 1985 little was known about the pesticide presence in Minnesota's ground water. These surveys conducted by the Departments of Health and Agriculture provided an initial perspective on the extent and concentration of pesticides in ground water in susceptible regions in Minnesota. These results have concerned both agencies. The surveys demonstrated the difficult and complex nature of the problem. Variations in pesticide presence and concentration existed with time and the depth of the sampling points beneath the water table. Pesticides were observed more frequently in observation wells and private drinking water wells than in public drinking water wells. The awareness of pesticide presence in ground and drinking water in Minnesota is having a tremendous impact on farmers, agribusiness, and regulatory agencies. Farmers are concerned. They are affected first, and potentially to the greatest extent. Farmers in Minnesota view ground-water quality as a very important issue, and this is especially true in hydrogeological regions. There continues to be an excellent amount of cooperation and a high degree of interest by farmers in dealing with this problem.

Farmers are anxious for the development of recommendations, information, and regulations that are based on agronomic and scientific facts. To be accepted these solutions must consider health, economic, and agronomic factors at the bare minimum. Because of the obvious complexity and time constraints in the development of these solutions, many farmers are reacting according to their own common sense and evaluation. These reactions include modifications of amounts, rates, and use of pesticide products. Around the farm there are currently increased safety measures when mixing, handling, and rinsing pesticides. Unfortunately, the additional information necessary to answer questions that now exist and to address the practical concerns of farmers is limited at this time. This problem needs to be addressed immediately.

In addition to farmers' concerns, the agricultural businesses are concerned also. First and foremost is a concern about water quality, but there is also a significant concern about over reaction, over regulation, and misplaced blame and liability. There is general confusion about the interpretation of health risk assessment data, regulatory responsibility, and accurate interpretation of complex data related to a relatively new environmental problem. In addition, there is a practical concern about the investment of capital in preventative measures without a guarantee that regulatory authorities will endorse those measures in the future, or without the knowledge that state-of-the-art preventative measures will work.

Protection of water quality is one of the most important issues to be addressed by the Minnesota Department of Agriculture in the immediate future. Nonpoint surveys will be coupled with an increased ability to respond to pesticide spills and other instances that may adversely affect water quality. Monitoring projects are currently underway that address aldicarb movement to ground water, pesticide presence, and atrazine concentration trends in hydrogeologically susceptible regions and area-specific studies. In addition, monitoring studies of surface water and effects of pesticide container dump sites are currently being planned.

The Minnesota Department of Agriculture, the lead State agency with regard to pesticide regulation, is in the process of implementing the 1987 State Pesticide Control Law Amendments. The amendments significantly broaden the Department's duties and responsibilities and included requirements to address pesticide impacts on water quality. In addition, the Department is actively participating in ground-water protection strategies that are being developed, and intends to develop a State Pesticide Management Plan.

The role of the Federal Government is crucial to the solution of complex environmental problems that face agriculture. Technical information on pesticides regarding environmental fate, health advisories, and analytical procedures is vitally necessary. It is inefficient and prohibitively expensive for States to develop this type of information. Information transfer between States needs to be facilitated so that research and information need not be duplicated, but there is also a need for Federal agencies to support States' efforts to conduct targeted surveys under local conditions. The EPA national pesticide survey is a good example of how a Federal agency's efforts can compliment States' efforts. One area of research that is greatly deficient is in the area of regulatory concerns. Funds need to be directed to research to encourage development of information which directly relates to and supports regulatory problems.

In summary, pesticide impacts are a very significant concern by Minnesota's farmers, agribusiness, and State agencies. Information, data, and technology is lacking and needs to be developed as quickly as possible, and certainly the role and the active involvement of the Federal Government is crucial to the development of solutions to these problems.

Thank you, Mr. Chairman.

Mr. OBERSTAR. Thank you very much, and I certainly agree wholeheartedly with your comment that the role of the Federal Government is crucial, its involvement is essential, and its funding is important, and as the entity that has the broadest national view of these issues it has to necessarily take the lead.

None of the panelists addressed one thing that I wanted to hear about, so let me ask. Is it getting worse or better or staying the same? By that I mean, is the level of pesticide contamination of ground-water expanding, is it becoming more difficult to deal with, or are we simply learning more about it today? Is it showing up in more and more unexpected places, or just what is your view from the ground level of this issue as to what the extent and seriousness and nature of this problem really is?

Dr. THRON. Mr. Chairman, let me first respond to that question regarding public drinking-water supplies. Prior to 1985 there has been virtually no testing of pesticide contamination in groundwater or drinking-water supplies, with the exception of six such pesticides that were required to be monitored as a part of the Safe Drinking Water Act. That has changed with the amendments to the Federal Safe Drinking Water Act. We will now be required to monitor for a lot more pesticides in public water supplies. Although we do not have that time-series of information where we could go back six, ten, or fifteen years to really answer that question, I would hope that during the next five to ten years, we will have a better indication of that. We do not have the answer to the question whether we are steady or whether it is gradually increasing, or whether the soils are assimilating the pesticides that are present.

Those six pesticides that I referred to are by-and-large banned pesticides, so we do not see those now in our current monitoring of drinking-water supplies. I might comment however, that part of our study on drinking water supplies, the part that was funded by the U.S. EPA, did deal with the short term time-series studies. Over a period of two years we took eight samples at 25 individual well sites and the result of that was that we detected pesticides in 24 of the 25 wells. That is not entirely indicative of whether the pesticide contamination problem is increasing or staying the same, but I think that it does indicate that over a time period, that at one point in the time of sampling or another point in the time of sampling, we were bound to find pesticides in detectable amounts. The exceedences that we found were only slightly above the recommended action levels that we had established, so we did not find a massive contamination situation, but nevertheless, we did find a high percentage of positives in that short period of time-series monitoring.

Mr. OBERSTAR. Mr. Buzicky.

Mr. BUZICKY. Mr. Chairman, we are continuing to do monitoring of some of the wells that we monitored in the period of 1985 to 1987. This was enabled by the Pesticide Control Law, which devoted a small amount of dollars for us to do so.

We are currently undergoing a significant drought, and the results that we are getting right now are sort of up in the air because we know that the drought is having significant effects and we have not really run enough samples at this time to understand that. We are hoping to know what those results will be at the end of the year, after a little bit of an evaluation looking at a number of wells a number of times. It should be remembered that in the study that we conducted in 1986 it was one of our wettest years in Minnesota and in fact, our agricultural areas where we were sampling received up to 20 inches above normal precipitation. Two years later we are now undergoing a severe drought, so it will give us an opportunity to see how the hydrogeologic cycle and the rainfall recharge affects this problem, which is fortunate from that perspective.

Mr. OBERSTAR. Last summer, I found it interesting, while visiting several of the farms that had been hit by last year's drought in the southern part of my district, that several of the farmers reported problems with their wells. With the lack of precipitation and low water levels in the wells, they had concentrations of nitrates, and they did not want to water their livestock because of their concern. So a drought period may have, by its lack of precipitation, the effect of concentrating dangerous chemicals in limited water supplies.

Mr. BUZICKY. That is one of the problems we were looking at in reverse in 1986. If we are getting excess rainfall are we moving more through, or are we actually providing excess water to dilute that amount of chemical that might be moving down. It is preliminary for us to make any evaluation of that but one of the things that we are having a problem with is that we are losing monitoring wells simply because the water table has dropped significantly in some areas.

Mr. OBERSTAR. I should think we would have to be very circumspect, because we are obviously at the very frontier of knowledge in this area.

Ms. DuBois.

Ms. DUBOIS. I would just like to comment that despite the fact that there have been a number of monitoring activities in New York State, what we appear to have is a series of snapshots. Except in Suffolk County, we do not have continuous monitoring of areas. There may be some money, so some monitoring can be done over a period of time in a limited number of wells. We may or may not be able to go back and resample, depending upon whether there is funding available. The only area where continuous monitoring goes on is in Suffolk County and that is, I believe, done by the Health Department. That is a luxury that many State and local agencies simply do not have the kind of money to do.

Mr. OBERSTAR. This matter of monitoring is one that it seems to me, we need to get on with. We need to develop this database in order to make the findings, conclusions, and recommendations for policy actions to be taken, but we have to have the data on which to take that action. A point that I would like to ask you to comment on is runoff versus percolation through ground water. How much monitoring, if any, has been done of streams and tributaries where runoff from open land occurs while monitoring ground water in the same area to determine how much is percolating through and how much is running off and being diverted from elsewhere?

Mr. BUZICKY. There have been a few studies that have been done nationally and in Ontario that I am aware of. It is not well understood. I know, for example, that Iowa has a significant problem with pesticides being found in surface water. We have done some surface water monitoring in the State. The Department of Health examines public drinking water supplies that we are drawing off of surface water, but we have not done a great deal. We have a proposal in at this time to do exactly that type of a study on three separate river systems in Minnesota and when I get back I hope I will have some positive news.

Mr. OBERSTAR. Is that State funded?

Mr. **Buzicky**. That would be the same funding source that was used to fund our ground water monitoring project, the Legislative Commission on Minnesota Resources.

Mr. **Oberstar**. That comes from the cigarette taxes, correct?

Mr. **Buzicky**. That is correct.

Ms. **DuBois**. I am not aware of studies of that sort that might have been done by that agency or by others like the department of Health. There is a small study going on in a number of streams in the farm country of western New York to look at what happens to the fisheries resource as a result of runoff from agricultural land. It is largely being driven by fish contamination, but there may be some interesting data that comes out of that as a result of knowing what crops are planted along the river and what chemicals you might expect to see and then doing some fish surveys to determine how many contaminants there are and levels of those contaminants. A very limited amount of work is being done, that I am aware of, but I do not really have the full picture on monitoring.

Mr. **Oberstar**. I think that is an area that we need to develop. The fact that such information is not being gathered is significant in itself, and Minnesota's initiative in this area would be very significant. I hope that funding will be provided, and we can probably talk to the EPA to see if they can join in this effort.

I had intended, had there been time, to mention to our EPA witness and our USDA witness that the two Federal Agencies ought to be in touch with the European Common Market, where there is a very significant runoff problem of various kinds of pesticides and fertilizers into the North Sea. We are now having widespread reports of red and brown algae waves throughout the North Sea, which until just the last five years has been a very clean body of water. Now these red and brown algae blooms are destroying fish life at an enormous rate and having a destructive effect upon harbor seals, who are dying by the hundreds. A massive testing program is now underway by the Dutch and Norwegians on harbor seals to analyze the bodies and to determine the chemicals that are causing these deaths. We can learn something from the Europeans, who are way ahead of us in damage of their environment, since they have been doing it for a much longer time and have had less of an environmental control program than we have in the United States. They are beginning to catch up but it is a very serious, widespread problem.

Is there any technology developed in any of the States on treatment in situ, that is in the well, as opposed to treatment at the tap? I know that you can attach activated carbon treatment systems to the tap but what about treatment in situ? Also, how effective is activated carbon and what other technologies are there for removal of contaminants.

Ms. DuBois.

Ms. **DuBois**. I do not have that information, but I would be glad to talk to our Division of Water people to find out and then provide you with that information.

Mr. **Oberstar**. That would be very helpful.

Dr. **Thron**. Mr. Chairman, let me make just one comment on that. When we sampled for pesticides from some of the surface waters in Minnesota, the Mississippi River and some others, we did find some low concentrations of pesticides in the raw water intake. We also found that the treated water did not result in any lowering of that pesticide concentration, so effectively, the treatment that is used by Minneapolis Water Utilities was ineffective in any removal of the pesticides.

Mr. **Oberstar**. So city dwellers can not take any comfort in being distant from point of application of pesticides if their treatment systems are not effective in removing them, can they?

Dr. **Thron**. Correct.

Mr. **Oberstar**. Do you have reports on the concentrations of pesticide contamination?

Dr. **Thron**. We do have reports. It was very limited in nature, and as Mr. Buzicky mentioned, more needs to be done on that. We felt that we needed to take a few samples because of the concern that was raised. The levels that we measured were low. They were below the State's recommended action levels so they did not, in our opinion, represent any type of health risk at that point. However, that was just a snapshot. I think that as a part of the Safe Drinking Water Amendments, we will be doing that periodic monitoring on a yearly basis for those systems. I thought it was more interesting that the raw water and the finished water concentrations were virtually identical. We did not see any discernable reduction with the treatment.

Mr. **Oberstar**. That is intriguing. It's remarkable.

Dr. **Thron**. There are probably other more expensive treatments that can be employed in situ or through a central treatment facility that will remove pesticides, some of them will volatilize, and perhaps air-stripping or other mechanisms can be used. The removal processes for pesticides from public water supplies is clearly an activity for the Municipal Engineering Laboratory of EPA in Cincinnati to devote some attention to.

Mr. **Oberstar**. Certainly, as we have learned in previous hearings of this subcommittee on the U.S. and Canada Great Lakes Water Quality Agreement, volatilizing contaminants in the water may have other effects. Pesticides get into the upper atmosphere and are transferred from as far away as Coast Rica to Lake Ontario, with DDT showing up in eastern Lake Ontario with deleterious effects upon birds and fish, pesticides can be transferred, within eight days from application, by the upper atmosphere, to in eastern Lake Ontario. There is just no free lunch in this environmental business. You have to be so careful about how water is treated and how chemicals are disposed of.

What is it about Long Island that makes it so vulnerable?

Ms. **DuBois**. Someone said earlier today that it is like one great big beach. The soil is very sandy and water goes through the soil very readily taking everything else down into the aquifer system below so that it is not just a matter of rainfall but many of the communities are on individual septic systems and those systems discharge also, so you have a circumstance where everything goes right into the ground water.

Mr. **Oberstar**. So there does not seem to be any curative quality of soils. They do not seem to be breaking down these pesticides as they move through layers of soil. They still show up in the drinking water.

Ms. DuBois. One of the problems that New York State has with that characterization is that it really ignores, in most places, the complex nature of the soil. It is not one simple soil type. Anybody that has ever looked at a soil map knows that, and anybody that has ever done any core sampling knows that you get a wide variety of soils and that therefore, to take the simplistic approach that you can somehow map vulnerability on a countywide basis and control pesticide use on that basis is, I think, going to really do very little in controlling pesticides migrating into ground water except in a case like Long Island, where it is pretty much sandy soil and you know what is going to happen. Most places are not like that. It is much more highly complex than that.

Mr. Oberstar. Have there been any studies conducted on the rate of migration of pesticides through soil?

Ms. DuBois. I have not seen a lot but one of the things that we expect to do is to take some of this data from the small plot aldicarb sampling study, because they looked at soil as well as water, so it may be possible to plot out at various places in that plot what happened as material moved through the soil. It was not uniform as it moved through the soil, depending on where the test wells were, and it just shows how highly complex the whole system is with respect to pesticide movement through the soil and into the ground water.

Mr. Oberstar. Mr. Buzicky, do you have a comment on that?

Mr. Buzicky. Just that as a soil scientist and doing work with nitrogen movement, there are a great many studies dealing with nitrate and nitrogen fertilizer movement as it moves through the profile. Studies have been done in Minnesota, Wisconsin, and most likely in every major university in the country. We are further behind on pesticides but there have been some studies done where you can interpolate some of the movement characteristics.

One of the things that we noted in our study was that some of the compounds that apparently break down more quickly were only found in the Spring of the year, shortly after application for example. Some of the other compounds that tend to be more persistent, such as atrazine, which was the most commonly found compound of the 30 different compounds we were looking for, was found prior to application and during the Winter. The persistence of the compound has got a great deal to do with it. The soil characteristics, such as sand on Long Island, would behave much differently than soils that have a higher organic matter or clay content or some of the heavier soils in southern Minnesota.

Mr. Oberstar. Given the fact that as recently as 1982 nearly half of all herbicide use was accounted for by four chemicals, alachlor, atrazine, butylate, and metalochlor, shouldn't research be concentrated on the persistence and behavior of those chemicals in different soils and under different conditions such as you just described?

Mr. Buzicky. I would agree that at that time there was a great concentration of those compounds. I think we are seeing some changes as newer compounds come on the market, which maybe are being used at lower rates. In fact, some of the research that has been recently initiated at the University of Minnesota is concentrating on some of the most likely compounds to leach. I know atrazine and alachlor are two of the compounds that the university is looking at in their leaching studies and best management practice studies.

Mr. Oberstar. As a soil scientist, could you comment on buildup in top soils of pesticides? Is there a certain persistence, or is there a tendency to concentrate at the upper levels of the soil zone, or do they spread out and are they diluted with runoff and percolation?

Mr. Buzicky. As far as pesticides go, that may be entirely dependent upon the compound's characteristics, its persistence, its resistance to degradation, the type of degradation, and I would suspect that even such things as how frequently the land is tilled, what kind of microbes are in it, and all kinds of other factors impact on the results. When we get into best management practices, these are the kinds of factors that need to be evaluated, how to promote effective use of herbicides and pesticides and also how to promote degradation once they have done their job.

Mr. Oberstar. That raises the question about no-till soil management, doesn't it? If tilling has an effect on the pesticide or is related to it, then how frequently you till that soil may have an effect on the concentrations of the pesticides in the upper level.

Mr. Buzicky. The whole area of this research is a scientist's delight because of the number of interactions that are possible. It is an extremely complex system that we are dealing with.

Mr. Oberstar. Thank you.

Counsel, any questions?

Mr. Goebel. No, sir.

Ms. DuBois. Mr. Chairman, I just wanted to add one further thing because it was a subject that came up in EPA's comments and I thought it worth commenting on. One of the devices that EPA is using in its strategy for these chemicals that are known or suspected to leach to ground water is the focus on applicator certification and training as one of the elements of reducing the possibility of pesticide contamination. While New York State is very interested and is actively involved in pursuing the upgrading of applicator certification and training, it would seem inappropriate to place a burden upon the individual user of making some of the kinds of choices about how they behave and how they apply materials that are much more highly complex matters than they as individual farmers are capable of handling. A sensitivity to the potential to leach to ground water is very important, but it would not seem appropriate that EPA should assume that it is going to protect ground water by training individual users, such as farmers, in handling pesticides. That is not going to make the problem go away.

Mr. Oberstar. I agree with that. I think that with their advance monitoring and testing of chemicals before they are released into the marketplace, such chemicals as are so very difficult to administer ought to be sorted out of the process and not burden the applicator. For one thing, you are not going to be able to reach everybody, and then there are mistakes made in the applications.

I wanted to ask also, have you set ground water standards, at what levels, and do you feel comfortable with the MCL standard that EPA is observing?

Dr. Thron.

Mr. **Oberstar**. Mr. Chairman, the State of Minnesota has not set ground water standards as yet, and is debating this very issue as you raise it. As you may be aware, the MCL standard is not, in its entirety, a health-based standard. It takes other factors into account, the achievability, technological ability to reduce to that level, as well as other factors. There is concern in our State about using that as a standard. The State is looking possibly at guidelines, and not perhaps attempting to adopt through rule something like the MCL because it changes quite often.

During the course of our pesticide study, the recommended atrazine action level had changed three times. We rely, of course, on information from the Environmental Protection Agency. It was originally at 262 parts per billion; it changed to 17; and now currently, we use three parts per billion as the recommended action level. There is some dynamic activity going on in those numbers, and there is concern about setting into rule some of these numbers, plus some of the other issues that have been raised.

Mr. **Oberstar**. You do not feel comfortable then, with EPA's MCL approach?

Dr. **Thron**. No, I do not. Perhaps I may be convinced at some further date, but if we are talking about protecting the ground water to a health standard, in some cases that standard might be higher than the MCL and in other cases it might be lower than an MCL, and I think that question needs to be resolved as well. Admittedly, it is a simple solution to use the MCL's as something that is already adopted by the Federal agency, but I think that one of the problems I could point out is that there is naturally occurring contamination that exists in ground water that is there not because of a result of man-made activities. For example, radium and radon in water are naturally occurring contaminants resulting from natural processes, and does it make sense to set an MCL standard for those where it occurs naturally?

Mr. **Oberstar**. Thank you.

Ms. DuBois.

Ms. **DuBois**. New York State has—and I will include a copy of regulations that set ambient water quality standards for 83 chemicals and also effluent discharge standards for 87 chemicals. The position of the Department is that we do not support MCL's as the trigger. We believe that the action level should be lower than the MCL if you are going to have what we think is essential, that is a ground water contamination prevention strategy.

[The following was received from Ms. DuBois:]

PART 703

GROUND WATER CLASSIFICATIONS, QUALITY STANDARDS AND EFFLUENT STANDARDS AND/OR LIMITATIONS

(Statutory authority: Environmental Conservation Law, §§ 17-0301, 17-0809)

Sec.
703.1 Definitions
703.2 Purposes of classifications, quality standards, and effluent standards and/or limitations
703.3 Collection of samples
703.4 Tests or analytical determinations
703.5 Classes and quality standards for ground waters
703.6 Effluent standards and/or limitations for discharges to class GA waters
703.7 Additional effluent standards and/or limitations
703.8 Modifications of effluent standards and/or limitations
703.9 Studies and monitoring
703.10 Exceptions
703.11 Assignment of ground water classifications and quality standards

Historical Note

Part (§§ 703.1-703.4) filed Mar. 20, 1967; repealed, new filed Apr. 28, 1972; repealed, new (§§ 703.1-703.11) filed Aug. 2, 1978 eff. 30 days after filing.

Section 703.1 Definitions. The terms, words or phrases used in this Part shall have the following meaning:

(a) *Administrator* shall mean the administrator of the United States Environmental Protection Agency.

(b) *Best usage of waters* as specified for each class shall be those uses as determined by the commissioner in accordance with the considerations prescribed by the Environmental Conservation Law.

(c) *Commissioner* shall mean the Commissioner of Environmental Conservation.

(d) *Consolidated rock* or *bed rock* is the compact or solid hard rock exposed at the surface of the earth or overlain by the unconsolidated deposits.

(e) *Department* shall mean the New York State Department of Environmental Conservation.

(f) *Disposal system* means a system for disposing of sewage, industrial waste or other wastes and including sewer systems and treatment works.

(g) *Effluent standard and/or limitation* shall mean any restriction on quantities, quality, rates and concentrations of chemical, physical, biological, and other constituents of effluents which are discharged or allowed to run from an outlet, point source or any other discharge within the meaning of Environmental Conservation Law, section 17-0501, into the unsaturated or saturated zones.

(h) *Fresh water* is that water having a chloride concentration equal to or less than 250 mg/l, or a total dissolved solids concentration equal to or less than 1000 mg/l.

(i) *Ground waters* are those waters in the saturated zone, including perched water areas.

(j) *Industrial waste* means any liquid, gaseous, solid or waste substance or a combination thereof resulting from any process of industry, manufacturing, trade, or business or from the development or recovery of any natural resources, which may cause or might reasonably be expected to cause pollution of the waters of the State in contravention of the standards adopted as provided in Environmental Conservation Law, article 17.

(k) *Land application techniques* include the following three basic methods of waste discharge application: irrigation; infiltration-percolation; and overland flow.

(l) *Land utilization practices* entails the use of plants, the soil surface, and soil matrix for removal of certain wastewater constituents.

(m) *Micrograms per liter, ug/l,* is the weight in micrograms of any specific substance or substances contained in one liter of solution.

(n) *Milligrams per liter, mg/l,* is the weight in milligrams of any specific substance or substances contained in one liter of solution.

(o) *Other wastes* means garbage, refuse, decayed wood, sawdust, shavings, bark, sand, lime, cinders, ashes, offal, oil, tar, dyestuffs, acids, chemicals, leachate, sludge, salt and all other discarded matter not sewage or industrial waste which may cause or might reasonably be expected to cause pollution of the waters of the State in contravention of the standards adopted as provided in Environmental Conservation Law, article 17.

(p) *Outlet* means the terminus of a sewer system, or the point of emergence of any water-borne sewage, industrial waste or other wastes or the effluent therefrom, into the saturated or unsaturated zones.

(q) *Pathogenic organism* shall mean any disease-producing organism.

(r) *Perched ground water* shall mean unconfined ground water separated from an underlying body of ground water by an unsaturated zone.

(s) *Person* or *persons* shall mean any individual, public or private corporation, political subdivision, government agency, municipality, industry, co-partnership, association, firm, trust, estate or any other legal entity whatsoever.

(t) *Point source* means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation or vessel or other floating stock from which pollutants are or may be discharged.

(u) *Pollutant* means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, and industrial, municipal, and agricultural waste discharged into water.

(v) *Pollution* shall mean the presence in the environment of conditions and/or contaminants in quantities of characteristics which are or may be injurious to human, plant or animal life or to property or which unreasonably interfere with the comfortable enjoyment of life and property throughout such areas of the State as shall be affected thereby.

(w) *Potable waters* are those fresh waters usable for drinking, culinary or food processing purposes.

(x) *Quality standard* shall mean such measure of purity or quality for any ground waters in relation to their best usage.

(y) *Saline water* is that water having a chloride concentration of more than 250 mg/l or a total dissolved solids concentration of more than 1000 mg/l.

(z) The *saturated zone* is that extensive portion of the earth's crust which is saturated with water. (Includes perched water areas.)

(aa) *Sewage* means the water-carried human or animal wastes from residences, buildings, industrial establishments or other places, together with such ground water infiltration and surface water as may be present.

(bb) *Subsurface sewage disposal system* shall mean a disposal system which discharges sewage beneath the surface of the ground.

(cc) *Toxic pollutant* means those pollutants, or combination of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly through food chains, will, on the basis of information available to the department, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, including malfunctions in reproduction, or physical deformations, in such organisms or their offspring.

(dd) *Treatment works* means any plant, disposal field, lagoon, pumping station, constructed drainage ditch or surface water intercepting ditch, incinerator, area devoted to sanitary land fills or other works not specifically mentioned herein, installed for the purpose of treating, neutralizing, stabilizing or disposing of sewage, industrial waste or other wastes.

(ee) *Unconsolidated deposits* are all non- or poorly indurated soil materials above the bedrock.

(ff) The *unsaturated zone* is that portion of the earth's crust which does not contain sufficient water to fill all interconnected voids or pore spaces. Perched water bodies may exist within the unsaturated zone.

(gg) *Waste management system* includes the management of mechanical equipment, crops, irrigation and monitors as an operational unit.

Historical Note

Sec. filed March 20, 1967; repealed, new filed:
April 28, 1972; Aug. 2, 1978 eff. 30 days after filing.

703.2 Purposes of classifications, quality standards, and effluent standards and/or limitations. The purpose of these classes, quality standards and effluent standards and/or limitations is to prevent pollution of ground waters and to protect the ground waters for use as potable water.

Historical Note

Sec. filed March 20, 1967; repealed, new filed:
April 28, 1972; Aug. 2, 1978 eff. 30 days after filing.

703.3 Collection of samples. (a) The determination of compliance or noncompliance of sewage, industrial waste or other waste discharges with the requirements of this Part shall be made through tests or analytical determinations of ground water or effluent samples collected in such manner as are approved by the department.

(b) The location at which ground water samples are collected shall be determined by the department. In selecting or approving such locations, the department shall consider all relevant facts, including but not limited to:

(1) the mobility of pollutants in the unsaturated zone is governed by the rate of movement of percolating water and the active pollutant attenuation mechanisms in this zone:

(2) attenuation mechanisms may remove potential pollutants in passage through topsoil and adequate thicknesses of the unsaturated zone; and

(3) attenuation of pollutant concentrations with distance may occur in the saturated zone, similar to that in the unsaturated zone, as a result of attenuation processes occuring below the water table.

(c) The location at which effluent samples are collected shall be at a point where the effluent emerges from a treatment works, disposal system, outlet or point source and prior to being discharged to the ground.

Historical Note

Sec. filed March 20, 1967; repealed, new filed:
April 28, 1972; Aug. 2, 1978 eff. 30 days after filing.

703.4 Tests or analytical determinations. Tests or analytical determinations to determine compliance or noncompliance with standards shall be made in accordance with:

(a) *Standard Methods for the Examination of Water and Wastewater* (see section 705.2 of this Title);

(b) *Methods for Chemical Analysis of Water and Wastes* (see section 705.2 of this Title);

(c) *Water Standards of the American Society for Testing and Materials* (see section 705.2 of this Title); or

(d) by other methods approved by the commissioner as giving results equal to or superior to methods listed above.

Historical Note

Sec. filed March 20, 1967; repealed, new filed: April 28, 1972; Aug. 2, 1978; amd. filed Nov. 5 1984 eff. Nov. 5, 1984.

703.5 Classes and quality standards for ground waters. (a) *Class GA.*

(1) The best usage of class GA waters is as a source of potable water supply. Class GA waters are fresh ground waters found in the saturated zone of unconsolidated deposits and consolidated rock or bed rock.

(2) Quality standards for class GA waters shall be the most stringent of:

(i) the items and specifications applicable to such waters found in this section;

(ii) the maximum contaminant levels for drinking water promulgated by the Commissioner of Health as found in 10 NYCRR Subpart 5-1, Public Water Supplies or any subsequent revision thereto or replacement thereof;

(iii) the maximum contaminant levels for drinking water promulgated by the administrator under the Safe Drinking Water Act (see section 705.1 of this Title) and 40 CFR Part 141, effective July 1, 1978 (see section 705.1); and

(iv) the standards for raw water quality promulgated by the Commissioner of Health as found in 10 NYCRR Part 170, Sources of Water Supply or any subsequent revision thereto or replacement thereof.

(3) The following quality standards shall be applicable to class GA waters:

Items	*Specifications*
(*a*) Sewage, industrial waste or other wastes, taste or odor producing substances, toxic pollutants, thermal discharges, radioactive substances or other deleterious matter.	None which may impair the quality of the ground waters to render them unsafe or unsuitable for a potable water supply or which may cause or contribute to a condition in contravention of standards for other classified waters of the State.
(*b*) The concentration of the following substances or chemicals:	Shall not be greater than the limit specified, except where exceeded due to natural conditions:
(*1*) Arsenic (As)	0.025 mg/l
(*2*) Barium (Ba)	1.0 mg/l
(*3*) Cadmium (Cd)	0.01 mg/l
(*4*) Chloride (Cl)	250 mg/l
(*5*) Chromium (Cr) Hexavalent	0.05 mg/l
(*6*) Copper (Cu)	1.0 mg/l
(*7*) Cyanide (Cn)	0.2mg/l
(*8*) Fluoride (F)	1.5 mg/l
(*9*) Foaming Agents[1]	0.5 mg/l
(*10*) Iron (Fe)[2]	0.3 mg/l

	Items	*Specifications*
(*11*)	Lead (Pb)	0.025 mg/l
(*12*)	Manganese (Mn)[2]	0.3 mg/l
(*13*)	Mercury (Hg)	0.002 mg/l
(*14*)	Nitrate (as N)	10.0 mg/l
(*15*)	Phenols	0.001 mg/l
(*16*)	Selenium (Se)	0.02 mg/l
(*17*)	Silver (Ag)	0.05 mg/l
(*18*)	Sulfate (SO_4)	250 mg/l
(*19*)	Zinc (Zn)	5 mg/l
(*20*)	pH Range	6.5-8.5
(*21*)	Aldrin, or 1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4a, 5, 8, 8a-hexahydro-*endo*-1, 4-exc-5, 8-dimethanonaphthalene.	not detectable[3]
(*22*)	Chlordane, or 1, 2, 4, 5, 6, 7, 8, 8-octachloro-2, 3, 3a, 4, 7, 7a-hexahydro-4, 7-methanoindene.	0.1 ug/l
(*23*)	DDT, or 2, 2-bis- (p-chlorophenyl)-1, 1, 1-trichloroethane and metabolites.	not detectable[3]
(*24*)	Dieldrin, or 6, 7-epoxy aldrin.	not detectable[3]
(*25*)	Endrin, or 1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, 8a-octahydro-endo-1, 4-*endo*-5, 8-dimethanonaphthalene.	not detectable[3]
(*26*)	Heptachlor, or 1, 4, 5, 6, 7, 8, 8-heptachloro-3a, 4, 7, 7a-tetrahydro-4, 7-methanoindene and metabolites.	not detectable[3]
(*27*)	Lindane and other Hexachlorocyclohexanes or mixed isomers of 1, 2, 3, 4, 5, 6-hexachlorocyclohexane.	not detectable[3]
(*28*)	Methoxychlor, or 2, 2-*bis*-(p-methoxyphenyl)-1, 1, 1-trichloroethane.	35.0 ug/l
(*29*)	Toxaphene (a mixture of at least 175 chlorinated camphene derivatives).	not detectable[3]
(*30*)	2, 4-Dichlorophenoxyacetic acid (2, 4-D)	4.4 ug/l
(*31*)	2, 4, 5-Trichlorophenoxypropionic acid (2, 4, 5-TP) (Silvex)	0.26 ug/l
(*32*)	Vinyl chloride (chloroethene)	5.0 ug/l
(*33*)	Benzene	not detectable[3]
(*34*)	Benzo (a) pyrene	not detectable[3]
(*35*)	Kepone or decachlorooctahydro-1, 3, 4-metheno-2H-cyclobuta (cd) pentalen-2-one (chlordecone).	not detectable[3]

	Items	*Specifications*	
(36)	Polychlorinated biphenyls (PCB) (Aroclor)	0.1 ug/l	
(37)	Ethylene thiourea (ETU)	not detectable[3]	
(38)	Chloroform	100 ug/l	
(39)	Carbon tetrachloride (tetrachloromethane)	5 ug/l	
(40)	Pentachloronitrobenzene (PCNB)	not detectable[3]	
(41)	Trichloroethylene	10 ug/l	
(42)	Diphenylhydrazine	not detectable[3]	
(43)	bis (2-chloroethyl) ether	1.0 ug/l	
(44)	2, 4, 5-Trichlorophenoxyacetic acid (2, 4, 5-T)	35 ug/l	
(45)	2, 3, 7, 8-Tetrachlorodibenzo-p-dioxin (TCDD)	3.5×10^{-5} ug/l	
(46)	2 - Methyl- 4 -chlorophenoxyacetic acid (MCPA)	0.44 ug/l	
(47)	Amiben, or 3-amino-2, 5-dichlorobenzoic acid (chloramben)	87.5 ug/l	
(48)	Dicamba, or 2-methoxy-3, 6-dichlorobenzoic acid	0.44 ug/l	
(49)	Alachlor, or 2-chloro-2', 6'-diethyl-*N*- (meth oxymethyl)-acetanilide (Lasso)	35.0 ug/l	0.5 ppb *
(50)	Butachlor, or 2-chloro-2', 6'-diethyl-N- (butoxymethyl)-acetanilide (Machete)	3.5 ug/l	
(51)	Propachlor, or 2-chlor-N-isopropyl-N-acetanilide (Ramrod)	35.0 ug/l	
(52)	Propanil, or 3', 4'-dichloropropionanilide	7.0 ug/l	
(53)	Aldicarb, [2-methyl-2-(methylthio) propionaldehyde *O*-(methyl carbamoyl) oxime] and methomyl [1-methylthioacetaldhyde *O*-(methyl-carbamoyl) oxime]	0.35 ug/l 7 ppb	
(54)	Bromacil, or 5-broma-3-sec-butyl-6-methluracil	4.4 ug/l	
(55)	Paraquat, or 1, 1'-dimethyl-4, 4'-dipyridylium	2.98 ug/l	
(56)	Trifluralin, or α, α, α-trifluoro-2, 6-dinitro-, N-dipropyl-p- toluidine (Treflan)	35.0 ug/l	
(57)	Nitralin, or 4-(methylsulfonyl)-2, 6-dinitro-N, N-dipropylaniline (Planavin)	35.0 ug/l	
(58)	Benefin, or N-butyl-N-ethyl-α, α, α-trifluoro-2, 6- dinitro-p-toluidine (Balan)	35.0 ug/l	

Wisconsin

	Items	Specifications	
(59)	**Azinphosmethyl, or *O, O*-dimethyl-S-4 oxo-1, 2, 3-benzotriazin-3 (4H)-ylmethylphosphorodithioate (Guthion)**	4.4 micrograms per liter	
(60)	**Diazinon, or *O, O*-diethyl O-(2)- isopropyl-4-methyl-6- pyrimidinyl)-Phosphorothioate**	0.7 micrograms per liter	
(61)	**Phorate (also for Disulfoton), or *O, O*-diethyl-*S*-[(ethylthio) methyl]-phosphorodithioate (Thimet R), and disulfoton, or *O, O*-diethyl-S-[(2-ethylthio) ethyl] phosphorodithioate (Di-System R)**	not detectable[3]	
(62)	**Carbaryl, or 1-naphthyl-N-methylcarbamate**	28.7 micrograms per liter	
(63)	**Ziram, or zinc salts of dimethyldithiocarbamic acid**	4.18 micrograms per liter	
(64)	**Ferbam, or iron salts of dimethyldithiocarbamic acid**	4.18 micrograms per liter	
(65)	**Captan, or *N*-trichloromethylthio-4-cyclohexene-1, 2-dicarboximide**	17.5 micrograms per liter	
(66)	**Folpet, or *N*-trichloromethylthiophthalimide**	56.0 micrograms per liter	
(67)	**Hexachlorobenzene (HCB)**	0.35 micrograms per liter	
(68)	**Paradichlorobenzene (PDB) (Also orthodichlorobenzene)**	4.7 micrograms per liter	
(69)	**Parathion (and Methl parathion), or (*O*,-*O*-diethyl-*O*-*p*-nitrophenylphosphorthioate, an methyl parathion, or *O*,*O*-dimethyl- *O*- *p*- nitrophenylphosphorothioate**	1.5 micrograms per liter	
(70)	**Malathion, or *S*-1, 2-*bis* (ethoxycarbony 1) ethyl-*O*,*O*-dimethylphosphorodithioate**	7.0 micrograms per liter	
(71)	**Maneb, or- manganese salt of ethylene- bis- dithiocarbamic acid**	1.75 micrograms per liter	
(72)	**Zineb, or zinc salt of ethylene-bis-dithiocarbamic acid.**	1.75 micrograms per liter	
(73)	**Dithane, or zincate of manganese ethylene-bis-dithiocarbemate**	1.75 micrograms per liter	
(74)	**Thiram, or tetramethylthiuramdisulfide**	1.75 micrograms per liter	
(75)	**Atrazine, or 2-chloro-4-ethylamino-6-isopropylamino-S-triazine**	7.5 micrograms per liter	3.5 ppb
(76)	**Propazine, or 2-chloro-4, 6-diissopropylamino-S-triazine**	16.0 micrograms per liter	

	Items	*Specifications*
(77)	Simazine, or 2-chloro-4, 6-diethylamino-S-triazine	75.25 micrograms per liter
(78)	Di-n-butylphthalate	770 micrograms per liter
(79)	Di (2-ethylhexyl) phthalate (DEHP)	4.2 milligrams per liter
(80)	Hexachlorophene, or 2, 2'-methylene-bis (3,4, 6-trichlorophenol)	7 micrograms per liter
(81)	Methyl methacrylate	0.7 milligrams per liter
(82)	Pentachlorophenol (PCP)	21 micrograms per liter
(83)	Styrene	931 micrograms per liter

Notes: [1] Foaming agents determined as methylene blue active substances (MBAS) or other tests as specified by the commissioner.

[2] Combined concentration of iron and manganese shall not exceed 0.5 mg/l.

[3] *Not detectable* means by tests or analytical determinations referenced in section 703.4.

(b) *Class GSA.* (1) The best usage of class GSA waters is as a source of potable mineral waters, for conversion to fresh potable waters, or as raw material for the manufacture of sodium chloride or its derivatives or similar products. Such waters are saline waters found in the saturated zone.

(2) The following quality standards shall be applicable to class GSA waters:

Items	*Specifications*
Sewage, industrial wastes or other wastes, color, taste or odor producing substances, toxic pollutants, thermal discharges, radioactive substances or other deleterious matter.	None which may impair the waters for use as sources of saline waters for the best usage outlines above or as to cause or contribute to a condition in contravention of standards for other classified waters of the State.

(c) *Class GSB.* (1) The best usage of class GSB waters is as a receiving water for disposal of wastes. Such waters are those saline waters found in the saturated zone which have chloride concentration in excess of 1,000 milligrams per liter or a total dissolved solids concentration in excess of 2,000 milligrams per liter.

(2) The following quality standards shall be applicable to class GSB waters:

Items	*Specifications*
Sewage, industrial wastes or other wastes, color, taste or odor producing substances, toxic pollutants, thermal discharges, radioactive substances or other deleterous matter.	None which may be deleterious, harmful, detrimental or injurious to the public health, safety or welfare or which may cause or contribute to a condition in contravention of standards for other classified waters of the State.

(3) Class GSB shall not be assigned to any ground waters of the State unless the commissioner finds that adjacent and tributary ground waters and the best usage thereof will not be impaired by such classification.

Historical Note

Sec. filed March 20, 1967; repealed, new filed: April 28, 1972; Aug. 2, 1978; amd. filed Nov. 5, 1984 eff. Nov. 5, 1984. Amended (a)(2)(iii).

703.6 Effluent standards and/or limitations for discharges to class GA waters.

(a) The effluent standards and/or limitations in schedules I and II of this section apply to a discharge from a point source or outlet or any other discharge within the meaning of Environmental Conservation Law, section 17-0501 which discharge will or may enter the unsaturated or saturated zones.

(b) The department may establish additional effluent standards and/or limitations as set forth in section 703.7 of this Part.

(c) The effluent standards and/or limitations shall be incorporated in SPDES permits (under Part 750 *et seq.* of this Title) for discharges to ground waters, where applicable.

Schedule I

Applicability. The following effluent standards and/or limitations shall apply to all class GA waters in New York State.

Biological organisms. Coliform and/or pathogenic organisms shall not be discharged in amounts sufficient to render fresh ground waters detrimental to public health, safety or welfare.

Chemical characteristics.

	Substance	*Maximum allowable concentration in mg/l (unless otherwise noted)*
(*1*)	Aluminum	2.0
(*2*)	Arsenic	0.05
(*3*)	Barium	2.0
(*4*)	Cadmium	0.02
(*5*)	Chloride	500
(*6*)	Chromium (Cr) (Hexavalent)	0.10
(*7*)	Copper	1.0
(*8*)	Cyanide	0.40
(*9*)	Fluoride	3.0
(*10*)	Foaming Agents[1]	1.0
(*11*)	Iron[2]	0.6
(*12*)	Lead	0.05
(*13*)	Manganese[2]	0.6
(*14*)	Mercury	0.004
(*15*)	Nickel	2.0
(*16*)	Nitrate (as N)	20
(*17*)	Oil and Grease	15
(*18*)	Phenols	0.002
(*19*)	Selenium	0.04
(*20*)	Silver	0.1
(*21*)	Sulfate	500
(*22*)	Sulfide	1.0
(*23*)	Zinc	5.0
(*24*)	pH Range[3]	6.5-8.5
(*25*)	Aldrin, or 1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4a, 5, 8, 8a-hexahydro-*endo*-1, 4-exo-5, 8-dimethanonaphthalene	not detectable[4]
(*26*)	Chlordane, or 1, 2, 4, 5, 6, 7, 8, 8-octachloro-2, 3, 3a, 4, 7, 7a-hexahydro-4, 7-methanoindene	0.1 ug/l

	Substance	*Maximum allowable concentration in mg/l (unless otherwise noted)*
(*27*)	DDT, or 2, 2-bis-(p-chlorophenyl)-1, 1, 1-trichloroethane and metabolites	not detectable[4]
(*28*)	Dieldrin, or 6, 7-epoxy aldrin	not detectable[4]
(*29*)	Endrin, or 1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, 8a-octahydro-endo-1, 4-*endo*-5, 8-dimethanonaphthalene	not detectable[4]
(*30*)	Heptachlor, or 1, 4, 5, 6, 7, 8, 8-heptachloro-3a, 4, 7, 7a-tetrahydro-4, 7- methanoindene and metabolites	not detectable[4]
(*31*)	Lindane and other Hexachlorocyclohexanes or mixed isomers of 1, 2, 3, 3, 5, 6-hexachlorocyclohexane	not detectable[4]
(*32*)	Methoxychlor, or 2, 2-*bis*-(*p*-methoxphenyl)-1, 1, 1-trichloroethane	35 ug/l
(*33*)	Toxaphene (a mixture of at least 175 chlorinated camphene derivatives)	not detectable[4]
(*34*)	2, 4- Dichlorophenoxyacetic acid (2, 4-D)	4.4 ug/l
(*35*)	2, 4, 5-Trichlorophenoxypropionic acid (2, 4, 5-TP) (Silvex)	0.26 ug/l
(*36*)	Vinyl chloride (chloroethene)	5.0 ug/l
(*37*)	Benzene	not detectable[4]
(*38*)	Benzo (a) pyrene	not detectable[4]
(*39*)	Kepone or decachlorooctahydro-1, 3, 4-metheno-2H-cyclobuta (cd) pentalen-2-one (chlordeone)	not detectable[4]
(*40*)	Polychlorinated biphenyls (PCB) (Aroclor)	0.1 ug/l
(*41*)	Ethylene thiourea (ETU)	not detectable[4]
(*42*)	Chloroform	100 ug/l
(*43*)	Carbon tetrachloride (tetrachloromethane)	5 ug/l
(*44*)	Pentachloronitrobenzene (PCNB)	not detectable[4]
(*45*)	Trichloroethylene	10 ug/l
(*46*)	Diphenylhydrazine	not detectable[4]
(*47*)	bis (2-chloroethyl) ether	1.0 ug/l
(*48*)	2, 4, 5-Trichlorophenoxyacetic acid (2, 4, 5-T)	35 ug/l
(*49*)	2, 3, 7, 8-Tetrachlorodibenzo-p-dioxin (TCDD)	3.5 x 10^{-5} ug/l
(*50*)	2- Methyl-4- chlorophenoxyacetic acid (MCPA)	0.44 ug/l

	Substance	Maximum allowable concentration in mg/l (unless otherwise noted)
(51)	Amiben, or 3-amino-2, 5-dichlorobenzoic acid (chloramben)	87.5 ug/l
(52)	Dicamba, or 2-methoxy-3, 6-dichlorobenzoic acid	0.44 ug/l
(53)	Alachlor, or 2-chloro-2', 6'-diethyl-*N*- (methoxymethyl)-acetanilide (Lasso)	35.0 ug/l
(54)	Butachlor, or 2-chlor-2', 6'-diethyl-N- (butoxymethyl)-acetanilide (Machete)	3.5 ug/l
(55)	Propachlor, or 2-chlor-N-isopropyl-N-acetanilide (Ramrod)	35.0 ug/l
(56)	Propanil, or 3', 4'-dichloropropionanilide	7.0 ug/l
(57)	Aldicarb, [2-methyl-2-(methylthio) propionaldehyde *O*-(methyl carbamoyl) oxime] and methomyl [1-methylthioacetaldehyde *O*- (methyl-carbamoyl) oxime]	0.35 ug/l
(58)	Bromacil, or 5-broma-3- sec-butyl-6-methluracil	4.4 ug/l
(59)	Paraquat, or 1, 1'-dimethyl-4, 4'-dipyridylium	2.98 ug/l
(60)	Trifluralin, or α, α, α-trifluoro-2, 6-dinitro-N-dipropyl-p-toluidine (Treflan)	35.0 ug/l
(61)	Nitralin, or 4-(methylsulfonyl) -2, 6-dinitro-N, N-dipropylaniline (Planavin)	35.0 ug/l
(62)	Benefin, or N-butyl-N- ethyl-α, α, α-trifluoro- 2, 6- dinitro-p-toluidine (Balan)	35.0 ug/l
(63)	Azinphosmethyl, or *O*, *O*-dimethyl-*S*- 4- oxo-1, 2, 3-benzotriazin-3 (4H)- ylmethylphosphorodithioate (Guthion)	4.4 ug/l
(64)	Diazinon, or *O*, *O*-diethyl *O*-(2-isopropyl- 4- methyl- 6-pyrimidinyl)-phosphorothioate	0.7 ug/l
(65)	Phorate (also for Disulfoton), or *O*, *O*- diethyl-*S*-[(ethylthio) methyl] -phosphorodithioate (Thimet R), and disulfoton, or *O*, *O*-diethyl-*S*- [(2-ethylthio) ethyl] phosphorodithioate (Di-System R)	not detectable[4]
(66)	Carbaryl, or 1-naphthyl-N-methylcarbamate	28.7 ug/l

	Substance	*Maximum allowable concentration in mg/l (unless otherwise noted)*
(67)	Ziram, or zinc salts of dimethyldithiocarbamic acid	4.18 ug/l
(68)	Ferbam, or iron salts of dimethyl-dithiocarbamic acid	4.18 ug/l
(69)	Captan, or *N*-trichloromethylthio-4-cyclohexene- 1, 2-dicarboximide	17.5 ug/l
(70)	Folpet, or *N*-trichloromethylthiophthalimide	56.0 ug/l
(71)	Hexachlorobenzene (HCB)	0.35 ug/l
(72)	Paradichlorobenzene (PDB) (also orthodichlorobenzene)	4.7 ug/l
(73)	Parathion (and Methyl parathion), or (*O*,-O-diethyl-*O*-*p*-nitrophenylphosphorthioate, and methyl parathion, or *O*, *O*-dimethyl-*O*-*p*- nitrophenylphosphorothioate.	1.5 ug/l
(74)	Malathion, or *S*-1, 2- *bis* (ethoxycarbonyl) ethyl- *O*, *O*-dimethylphosphorodithioate	7.0 ug/l
(75)	Maneb, or-manganese salt of ethylene- bis- dithiocarbamic acid	1.75 ug/l
(76)	Zineb, or zinc salt of ethylene-bis-dithiocarbamic acid	1.75 ug/l
(77)	Dithane, or zincate of manganese ethylene- bis- dithiocarbamate	1.75 ug/l
(78)	Thiram, or tetramethylthiuramdisulfide	1.75 ug/l
(79)	Atrazine, or 2- chlor- 4- ethylamino- 6- isopropylamino-S-triazine	7.5 ug/l
(80)	Propazine, or 2-chloro-4, 6-diisopropylamino-S-triazine	16.0 ug/l
(81)	Simazine, or 2- chloro-4, 6-diethylamino-S-triazine	75.25 ug/l
(82)	di-n-butylphthalate	770 ug/l
(83)	Di (2-ethylhexyl) phthalate (DEHP)	4.2 mg/l
(84)	Hexachlorophene, or 2, 2'-methylene-bis (3, 4, 6-trichlorophenol)	7 ug/l
(85)	Methyl methacrylate	0.7 mg/l
(86)	Pentachlorophenol (PCP)	21 ug/l

	Substance	Maximum allowable concentration in mg/l (unless otherwise noted)
(87)	Styrene	931 ug/l

Notes: [1] Foaming agents determined as methylene blue active substances (MBAS) or other tests as specified by the commissioner.

[2] Combined concentration of iron and manganese shall not exceed 1.0 mg/l.

[3] When natural ground waters have a pH outside the range indicated above, that natural pH may be one extreme of the allowable range.

[4] *Not detectable* means by tests or analytical determinations referenced in section 703.4 of this Part.

Schedule II

Applicability. In addition to the effluent standards and/or limitations in Schedule I, the following also apply in the counties of Nassau and Suffolk:

Chemical Characteristics.

	Substance	Maximum allowable concentration in mg/l
(1)	Dissolved Solids, Total	1000
(2)	Nitrogen, Total (as N)	10

Historical Note

Sec. filed Aug. 2, 1978 eff. 30 days after filing.

703.7 Additional effluent standards and/or limitations. (a) The department, after consultation with the State Department of Health, may establish on a case by case basis more stringent effluent standards and/or limitations than those set forth in schedule I or II of section 703.6 of this Part and may impose effluent standards and/or limitations for a toxic pollutant or any substance not included in schedule I or II, when necessary, to prevent pollution and protect the ground waters for their best usage. The department shall consider rules and regulations promulgated by the administrator or the New York State Department of Health in establishing such standards and/or limitations. Additionally, the department shall consider action levels for compounds determined to exhibit toxic effects which are established by the New York State Commissioner of Health.

(b) Circumstances under which the department may consider more stringent effluent standards and/or limitations include, but are not limited to:

(1) a discharge to an aquifer which is the sole or principal source of a potable water supply;

(2) an existing or proposed discharge is directly on or into consolidated rock or bed rock;

(3) a discharge containing one or more substances which in combination with precipitation and/or natural soil constituents is likely to produce a toxic pollutant; or

(4) where adverse accumulative or synergistic effects can be established for constituents in a discharge.

(c) Where a discharge is proposed or exists which would or does contain a pollutant for which there is a quality standard under this Part but there is no applicable effluent standard and/or limitation under this Part for such a pollutant, the department, after consultation with the New York State Department of Health, shall establish effluent standards and/or limitations for such pollutant on a case by case basis.

Historical Note

Sec. filed Aug. 2, 1978 eff. 30 days after filing.

703.8 Modifications of effluent standards and/or limitations.

(a) (1) A person responsible for a discharge subject to this Part may petition in writing for a modification of the effluent standards and/or limitations found in section 703.6 or established pursuant to section 703.7 of this Part.

(2) Such person shall have the burden of establishing to the satisfaction of the commissioner, after his consultation with the New York State Commissioner of Health, that one or more of the effluent standards and/or limitations are unnecessarily restrictive as to a particular discharge in that such modification of certain standards and/or limitations would, notwithstanding noncompliance with such standards and/or limitations, prevent pollution and protect the ground waters for their best usage.

(b) The regulations contained in Part 753 of this title prescribing procedures for notice and public participation shall apply whenever a person petitions for a modification of effluent standards and/or limitations established pursuant to section 703.6 of this Part.

Historical Note

Sec. filed Aug. 2, 1978 eff. 30 days after filing.

703.9 Studies and monitoring. (a) The department may require the submission of information by any person responsible for a discharge in order that the department may evaluate the short- and/or long-term effect the discharge may have on ground waters of the State or for the purpose of determining additional effluent standards and/or limitations or modifications thereto, as set forth in sections 703.7 and 703.8 of this Part, respectively. Such information may include, but is not limited to:

(1) a statement of the property to be affected by a discharge and the extent to which such property is under the control of the person responsible for such discharge;

(2) a geohydrologic analysis of the aquifer(s) which may be affected;

(3) a determination of the direction and rate of movement of the discharge and the natural ground water;

(4) an evaluation of adverse effects a discharge may have on any aquifer, source of potable water supply, or other surface and ground waters of the State; and

(5) an evaluation of the ability of unconsolidated deposits, consolidated rock or bed rock and the ground waters to attentuate potential pollutants such that the best usage of the ground waters is maintained.

(b) The department may require the installation and operation of monitoring facilities in order to assure compliance with effluent standards and/or limitations or to evaluate the effect of the discharge on the quality of the ground water. Specific monitoring requirements shall be established by the department on a case-by-case basis and as may be required by Part 756 of this Title.

Historical Note

Sec. filed Aug. 2, 1978 eff. 30 days after filing.

Mr. **Oberstar**. Thank you, I appreciate that.

Mr. Clinger.

Mr. **Clinger**. Thank you very much, Mr. Chairman.

I want to thank the panel for their very real help in our deliberations here in what is obviously an emerging but very serious problem. It is going to require a lot of policy decisions down the road.

One thing that you said at the outset, Ms. DuBois, was that whereas a number of the wells in upstate New York had been closed down for contamination, some had been reopened, and I wondered what led to their reopening, what process went forward to enable them to be reopened?

Ms. **DuBois**. I would be glad to supply that. I don't have the information. I assumed that whatever pesticide or chemical levels were present were reduced naturally over a period of time so that they were lower than the action levels which the State Department of Health has.

Mr. **Clinger**. So, as far as you know, there wasn't any specific action taken.

Ms. **DuBois**. As far as I know, no.

Mr. **Clinger**. After conducting your individual State surveys in Minnesota and New York of ground water and well contamination by pesticide, did you make any attempt to correlate your findings with the results from the Economic Research Study?

Ms. **DuBois**. No.

Mr. **Clinger**. You did not?

Ms. **DuBois**. No.

Mr. **Clinger**. What about Minnesota?

Mr. **Buzicky**. We have not attempted to correlate that directly. But I would say—and it's in the report that you have a copy of—that the primary areas of contamination would be the areas that would show up as highly susceptible. That, of course, would be textured soils with shallow depth to ground water in our karst region of southeastern Minnesota.

Within certain areas it was noted though—because of the way the studies were conducted—that, for example, a county that had an alluvial valley where irrigation was taking place and, of course, had textured soils, but the dominant soil type might be a heavy silt loam with high organic matter, could show contamination.

On a sensitivity map such as Drastic, that county, as a county, would show up as a relative low sensitivity county if no herbicides and insecticides were being used there. But if you take the samples in the highly susceptible areas within that county, you will find some pesticides, just like in a county that has dominant soils that are susceptible.

Mr. **Clinger**. Yes.

Of the incidents of contamination which were detected, can you make a determination on how many of them would be attributable to agricultural applications, and how many would be attributable to point source contamination? Do either one of you have any data on what is point source and nonpoint source contamination?

Mr. **Buzicky**. It becomes very difficult to actually ascertain where the pesticide compound is coming from, and what is the original source.

Basically, we did monitor three different types of wells. The Department of Health sampled community water supplies, which are generally located near the city and are high capacity. There was also a number of private wells that were sampled. These are usually in farm yards, so there you have a chance of contamination from normal use around the farm site and also incidental spillage. Then the Department of Agriculture focused on monitoring wells that were close to the fields.

Basically what we found is that the private water supplies of the monitoring wells did show about the same frequency of detections, generally about the same compounds. The public water supplies that the Department of Health sampled showed less frequent and slightly lower concentrations of compounds but, again, about the same list of compounds.

Interpreting that, I would say the monitoring wells probably reflected more normal use, although these were not controlled sites. So even though a well is in the middle of an open agricultural area, there is no assurance that a spill did not occur in the ditch, or in the field, or on the highway, or something like that.

Mr. CLINGER. So it is really very difficult to quantify how much might be attributable to what source.

Mr. BUZICKY. It is extremely difficult.

Mr. CLINGER. Another subcommittee I sit on held a hearing earlier this year on low input farming and what the USDA is doing to encourage that, as they are required to do by law. In low input farming, the application of pesticides and fertilizers is held down to a very low minimum.

I take it that you would be supportive of these efforts. I am wondering if the States generally have a role to play in promoting this form of agriculture. Are you promoting this form of agriculture? If so, how?

Ms. DUBOIS. Well, I think the answer to the question: do we have a role? is yes.

The question of how is something that I think we are grappling with in New York. There is a limited amount of money that is assigned by the State legislature to integrated pest management programs in New York. That goes to the Department of Agriculture, who gives some of it, if now all of it, to Cornell University as the land grant college. They are doing research and outreach on integrated pest management.

I don't believe, as a State, that we are doing nearly enough to educate the individual farmer in the field about how they can reduce pesticide and fertilizer use on a daily basis. It is happening on an individual user basis. That means there are a lot of people we have to get to if we go that direction. I think we have to do a lot more.

Mr. CLINGER. How about Minnesota? Is there any effort in terms of education with regard to low input farming?

Mr. BUZICKY. There is quite a bit actually. The Department of Agriculture has utilized some Exxon energy refund dollars to fund some demonstration sites on farms in the State to deal with low energy input.

There was $1 million appropriated by the State legislature to fund low interest loans to farmers who wished to convert to low energy type field equipment and try demonstration projects for their own purposes; things like that.

In addition, the University of Minnesota is involved in the whole concept of and is doing research on low energy input farming.

Mr. **Clinger**. Thank you, Mr. Chairman.

Mr. **Oberstar**. Thank you for raising that matter of low input farming. That elicited some very good responses.

I am going to thank our witnesses for being so cooperative and for putting such a great deal of effort and time into well-prepared and well thought out statements.

[The prepared statements of Dr. Thron, Mr. Buzicky, and Ms. DuBois follows:]

TESTIMONY

presented to

Subcommittee on Investigations and Oversight
Committee on Public Works and Transportation

One Hundredth Congress

U.S. House of Representatives

by

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PESTICIDES AND GROUND WATER

Issue Description

Pesticides are used extensively in agricultural crop production. In a Minnesota Agricultural Statistics Service publication covering the 1984 crop year, Minnesota farmers were reported to have used pesticides on over 96 percent of their corn, soybean and sugar beet acreage, nearly 90 percent of their wheat and sunflower acreage and on 60 percent of their small grain acreage. In total, an estimated 40 to 45 million pounds of active pesticidal ingredients were applied to approximately 16.5 million acres of Minnesota farmland during the 1984 crop year.

This extensive pesticide use has both benefits and risks. Pesticide use has allowed farmers to increase crop yields while decreasing the time and fuel spent on crop production. At the same time, there has been increasing evidence that certain pesticides are entering ground and surface waters, posing a potential threat to drinking water.

State Pesticide Monitoring Surveys

In response to concerns generated by the detection of pesticides in certain Iowa and Wisconsin ground waters and by the limited pesticide monitoring data available for Minnesota ground waters, the Minnesota Departments of Health (MDH) and Agriculture (MDA) initiated cooperative surveys of water wells for selected pesticides. The surveys were funded by the Legislative Commission on Minnesota Resources (LCMR) and the United States Environmental Protection Agency (EPA) and were intended to provide baseline information on the occurrence and extent of agricultural pesticide contamination in the State's ground water and drinking water wells. The report "Pesticides and Groundwater: Surveys of Selected Minnesota Wells" is a product of these surveys.

The surveys sampled wells in 77 counties between July 1985 and June 1987. The MDA sampled 100 observation, irrigation, and private drinking water wells and five tile lines on a time-series or repetitive basis (typically, four samples per site). The MDH collected a single sample from 400 public and 200 private drinking water wells. A second sample was collected from each well in which pesticides were detected in the initial sample. The MDH also conducted repetitive sampling (eight samples per site) of 25 private or public drinking water wells which draw water from sensitive geologic formations in the State, notably the karst formations in southeastern Minnesota. These formations present unique hydrological conditions which are not adequately measured by one-time sampling.

In general, survey wells were selected in agricultural regions and, within those regions, from areas where the local or regional soils and hydrogeologic conditions made the ground water especially susceptible to pesticide contamination. Karst aquifers and shallow sand and gravel aquifers overlain by coarse-textured soils were viewed as particularly sensitive and most likely to show evidence of pesticide-related ground water contamination.

The karst region in southeastern Minnesota is generally characterized by shallow depths to porous and permeable carbonate bedrock and, in some areas, by features such as sinkholes, caves and disappearing streams. These conditions can result in rapid transport of surface water containing dissolved or soilbound pesticides into the groundwater.

Shallow sand and gravel aquifers overlain by coarse-textured, low organic matter soils occur throughout the State and are particularly widespread in central Minnesota. These aquifers are comprised primarily of glacial outwash and alluvial deposits, but also include beach ridge deposits in northwestern Minnesota. The potential for pesticide movement to ground water is increased in these areas because the soils typically allow rapid water infiltration and have a low capacity for adsorption of organic compounds. Irrigation, which is commonly practiced in many of these areas, may also contribute to the downward migration of pesticides.

Additional well selection criteria were also used. Some wells were selected to provide areal coverage of the State's agricultural regions and diverse cropping patterns. The MDH selected several public drinking water wells based on historically high or fluctuating nitrate levels (greater than one milligram per liter) or on the wells' proximity to bulk pesticide storage and handling facilities.

Analysis and Survey Results

The results of the surveys indicated that several pesticides were present in ground water and drinking water wells, especially in the hydrogeologically sensitive areas of the State. The analytical results are presented in Tables 2-6 and Figures 2-8 of the attached paper.*

In total, one or more pesticides were detected in 281 (39 percent) of the 725 wells sampled and in three of the five tile lines sampled. Sixteen pesticides, including fourteen herbicides, one insecticide and one wood preservative, were detected in the surveys. Atrazine, a pesticide commonly used in corn production, was found in 266 (37 percent) of the wells and was the most commonly detected pesticide in each survey phase. Alachlor and 2,4-D, the next most frequently occurring pesticides, were found in 40 and 13 of the wells, respectively. Each of the remaining thirteen pesticides was detected in nine or fewer wells. Multiple pesticides were present in 55 wells.

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*"Pesticides and Groundwater: Survey of Selected Minnesota Wells," paper presented at Agricultural Impacts on Ground Water Conference, Des Moines, Iowa, March 22, 1988. (Copy of paper attached to this testimony.)

Although the percentage of wells with detectable levels of pesticides was relatively high, the concentrations detected were usually low. Eighty-three percent of all pesticide occurrences were at concentrations less than 1.0 microgram per liter (µg/l). Levels exceeding the MDH Recommended Drinking Water Limits were observed in samples collected from 16 drinking water wells, including five public wells and 11 private wells.

Pesticides were detected in wells in 51 of 77 counties sampled, but were most commonly found in wells completed in karst formations in southeastern Minnesota, the shallow, outwash sand and gravel aquifers in central Minnesota, and the shallow, alluvial sand and gravel aquifers in southwestern Minnesota. Few pesticide occurrences were observed in northwestern and south central Minnesota.

State Policy and Strategy Development

Minnesota is active in addressing the issues of ground water contamination by pesticides and in developing policy and management strategy to assure long-term water quality protection. The report "Pesticides and Groundwater: Surveys of Selected Minnesota Wells" represents one of several multi-agency efforts to confront the pesticide issue.

Through the leadership of the Minnesota Environmental Quality Board, two management strategies are under preparation which focus on pesticide management in Minnesota. One involves the writing of a "Minnesota Ground Water Protection Strategy," and the other a "Pest and Nutrient Management Strategy." A standing Water Resources Committee of the Minnesota Environmental Quality Board (EQB) is providing oversight to the development of these strategies. Contributing to the development and writing of these strategies are the members of the EQB's Water Resources Committee, which include the Minnesota Pollution Control Agency, the Minnesota Department of Health, the Minnesota Department of Natural Resources, the Minnesota State Planning Agency, the Minnesota Department of Agriculture, the University of Minnesota, the Minnesota Board of Water and Soil Resources, and the Minnesota Waste Management Board. This collection of Minnesota agencies, departments and institutions results in a diversity of expertise, management perspective and opinion.

The Ground Water Protection Strategy will serve as a blueprint for future ground water management activities at the State level and also help define the local role in ground water management and protection. The Strategy is built on the strong regulatory framework which the State has established. State agencies already have statutory authority to establish ground water standards and regulate pollution sources to protect and monitor drinking water supplies, to regulate appropriation, and to regulate the sale and use of agricultural chemicals which may impact ground water quality.

The Strategy has been structured around four major initiatives:

I. To protect ground water quality now and for the future, to ensure safe drinking water supplies, and to prevent ground water contamination by effectively regulating sources of pollution.

II. To ensure adequate water supplies, to regulate water appropriation and use for protection of highest priority users, and to improve coordination of quality and quantity aspects of regulatory programs.

III. To enhance the current body of knowledge on Minnesota's ground water resource, delineating problem areas and providing information needed to effectively manage the resource.

IV. To provide the public, decision-makers, regulators, and the regulated community with the necessary information and education for making environmentally sound decisions in areas which may impact ground water.

Basic tenets to these initiatives in the Ground Water Strategy are:

1. Ground water is a resource vital to the economic and public health of Minnesota.

2. The State needs a strong, prevention-based program when dealing with potential sources of ground water contamination.

3. Clear goals for ground water protection should be incorporated into all programs which control potential sources of ground water contamination.

4. Ground water withdrawals should not be allowed which result in "mining" of water beyond the amount replenished by recharge.

5. More basic information on Minnesota's ground water is critical.

6. Ground water programs should be conducted at the most local level appropriate.

7. Coordination between levels of government and governmental entities is vital to efficient ground water protection.

8. People must understand the impacts that their various practices and activities have on the environment, and be educated in ways to minimize or alleviate those impacts.

The Pest and Nutrient Management Strategy builds upon the framework established in the Minnesota Ground Water Protection Strategy. Initiatives and tenets under consideration include:

1. Foster an integrated approach to pesticide management which includes education, research, monitoring, incentives, regulation and coordination.
2. Strive for modifications in individual behavior and actions.
3. Emphasize land stewardship and resources sustainability.
4. Prevention should be the cornerstone.
5. Nondegradation should be the goal.
6. Degradation should be met with action.
7. Actions should be geared toward environmental and health protection.

In addition to the management strategies mentioned above, the Minnesota Environmental Quality Board bi-annually prepares water resource protection priority recommendations for consideration by the Minnesota Legislature. The Legislature must approve all State agency budget and work program activities.

Federal Government Roles

Federal agencies, particularly the U.S. Environmental Protection Agency, need to continue an active involvement in developing pesticide and ground water management strategies, support for monitoring programs, and support basic and applied research. The U.S. EPA should act as a facilitating agent in assuring that information from many other federal agencies is identified and brought together and made readily available to state and local government.

Basic and applied research is best coordinated at the federal level. The U.S. EPA's Office of Research and Development, through its national laboratories and health assessment sections, should exercise a coordinating leadership on the pesticide issue. Of particular importance are (1) continued research into the health effects of chronic low-dose exposure to pesticides in drinking water supplies; (2) development and improvement upon analytical methods and techniques for measuring pesticides; (3) investigations into the breakdown products of pesticides, many of which may be more toxic than their parent compounds; and (4) continued research into the transport and fate of pesticides in the soil, water and air environment. The volatization of pesticides into air contaminants and re-deposition elsewhere into surface waters needs more attention.

Congressional passage of a ground water management strategy providing a framework of federal water policy is urgently needed. The respective roles of federal agencies in partnership with states needs to be elaborated. Attention is very much needed regarding the protection of rural water supplies. Programs for wellhead protection, which prevent contamination from intruding into water well supplies are, ultimately, much more cost effective and provide the continuance of public health protection.

Conclusions

Certain pesticides have been detected in Minnesota's ground water and drinking water, especially in hydrogeologically sensitive areas of the State. Although the percentage of wells with detectable levels of pesticides was relatively high, the concentrations detected were usually low. The widespread occurrence of pesticides, primarily atrazine, at low concentrations in certain areas, and the presence of pesticides in observation wells located near field application sites indicate that ground water contamination may result from normal pesticide use as well as from point sources of contamination, such as spills.

While pesticides were observed more frequently in wells in certain areas of the State, the potential for contamination in a specific well is influenced by a complex set of factors, including the source and chemical properties of the contaminant, well construction, local ground water vulnerability, and local agricultural practices. These factors can vary considerably from area to area, as well as from well to well.

Nevertheless, the occurrence of certain pesticides in ground water, the unknown human health implications resulting from exposure to low levels of pesticides in drinking water, and the many unresolved questions related to the complex movement and fate of pesticides in the environment raise significant issues which must be addressed. Additional monitoring, research, regulatory and educational efforts will be needed to minimize the impact of pesticides on water quality and public health. The Environmental Quality Board's Water Resources Committee is currently addressing these concerns by developing a State water resource strategy for the control of pests and management of nutrients.

PESTICIDES AND GROUNDWATER:

SURVEYS OF SELECTED MINNESOTA WELLS

Minnesota Department of Health
and
Minnesota Department of Agriculture

Agricultural Impacts on Groundwater Conference

National Water Well Association

Des Moines, Iowa

March 22, 1988

Presented by Tomas Klaseus
Minnesota Department of Health
717 S.E. Delaware Street
Minneapolis, Minnesota 55440

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PESTICIDES AND GROUNDWATER:

SURVEYS OF SELECTED MINNESOTA WELLS

Tomas G. Klaseus, Minnesota Department of Health
Greg C. Buzicky, Minnesota Department of Agriculture
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ABSTRACT

Between July 1985 and June 1987, the Minnesota Departments of Health (MDH) and Agriculture (MDA) conducted cooperative surveys of water wells for selected pesticides. The surveys were funded by the Legislative Commission on Minnesota Resources and the United States Environmental Protection Agency and were intended to provide baseline information on the occurrence and extent of agricultural contamination in the State's groundwater and drinking water. Over 700 wells, including observation wells and public and private drinking water wells, were tested as part of the total effort. Wells were generally selected for sampling in agricultural regions and, within those regions, from areas where the local or regional soils and hydrogeologic conditions make the groundwater especially susceptible to pesticide contamination. Some wells were also selected outside of these sensitive areas to provide areal coverage of the State's agricultural regions and diverse cropping patterns.

The results of the surveys indicated that several pesticides were present in groundwater, especially in hydrogeologically sensitive areas of the State. One or more pesticides were detected in 281 (39 percent) of the 725 sampled wells. Sixteen pesticides, including fourteen herbicides, one insecticide and one wood preservative, were detected in the surveys. Atrazine, the most commonly detected pesticide in each survey, was found in 266 (37 percent) of the sampled wells. Although the percentage of wells with detectable levels of pesticides was relatively high, the concentrations detected were usually low (typically less than one microgram per liter). Levels exceeding the State's recommended drinking water limits were observed in samples collected from sixteen drinking water wells, including five public wells and eleven private wells. The widespread occurrence of pesticides, primarily atrazine, at low concentrations in certain areas, and the presence of pesticides in observation wells located near field application sites, indicate that groundwater contamination may result from normal pesticide use as well as from point sources of contamination.

INTRODUCTION

Agricultural lands in Minnesota account for over 30 million of the State's 53 million total acres. In 1986, Minnesota ranked fifth in the nation in crop acreage planted with 20.6 million acres under cultivation. A wide range of soil and climatic conditions result in diverse cropping patterns across the State. The most widely planted crops are corn, soybeans, wheat, barley, oats and alfalfa. Other crops of local or regional significance include sugar beets, sunflowers, potatoes, sweet corn, rye, peas, edible beans and flax.

Pesticides are used extensively in agricultural crop production. In a Minnesota Agricultural Statistics Service publication covering the 1984 crop year, Minnesota farmers were reported to have used pesticides on over 96 percent of their corn, soybean and sugar beet acreage, nearly 90 percent of their wheat and sunflower acreage and on 60 percent of their small grain acreage. In total, an estimated 40-45 million pounds of active pesticidal ingredients were applied to approximately 16.5 million acres of Minnesota farmland during the 1984 crop year.

This extensive pesticide use has both benefits and risks. Pesticide use has allowed farmers to increase crop yields while decreasing the time and fuel spent on crop production. At the same time, there has been increasing evidence that certain pesticides are entering ground and surface waters, posing a potential threat to drinking water.

In response to concerns generated by the detection of pesticides in certain Iowa and Wisconsin groundwaters and by the limited pesticide monitoring data available for Minnesota groundwaters, the Minnesota Departments of Health (MDH) and Agriculture (MDA) initiated cooperative surveys of water wells for selected pesticides. The surveys were funded by the Legislative Commission on Minnesota Resources (LCMR) and the United States Environmental Protection Agency (U.S. EPA) and were intended to provide baseline information on the occurrence and extent of agricultural pesticide contamination in the State's groundwater and drinking water.

All samples were collected between July 1985 and June 1987. The MDA sampled 100 observation, irrigation, and private drinking water wells and five tile lines on a time-series or repetitive basis (typically, four samples per site). The MDH collected a single sample from 400 public and 200 private drinking water wells. A second sample was collected from each well in which pesticides were detected in the initial sample. The MDH also conducted repetitive sampling (eight samples per site) of 25 private/public drinking water wells which draw water from sensitive geologic formations in the State, notably the karst formations in southeastern Minnesota. These formations present unique monitoring requirements which are not adequately addressed in a one-time sampling.

PESTICIDE SELECTION

The pesticide selection process involved the evaluation of information and data related to use, toxicology and environmental transport and fate. Pesticide use information was obtained, primarily from the Minnesota Agricultural Statistics Service, for each of the major crops grown in the State. Information on toxicology and environmental transport and fate was obtained, in part, through consultation with the MDH's Section of Health Risk Assessment, the University of Minnesota and other State agencies. Work performed by the U.S. EPA and the states of Wisconsin, California and Iowa was also utilized. Limited information was available on the environmental transport, fate and toxicology of many of the compounds considered for the surveys.

After evaluation of existing information, the MDH and MDA jointly selected 45 pesticides for further consideration. Emphasis in the final selection was placed on those pesticides which were commonly used in the State and/or which appeared to be more likely to adversely impact groundwater and public health.

The MDH and MDA laboratories were requested to develop and verify analytical methods for the selected pesticides. The two laboratories coordinated efforts to ensure that similar analytical methods and reporting limits would be developed and used in the surveys. Some variation resulted from differences in laboratory equipment, procedures and personnel, but these variations did not significantly affect the findings of these surveys.

Due to time constraints and limitations in laboratory capability, analytical methods were developed and verified for only 30 of the 45 pesticides on the original list. These pesticides and their reporting limits are presented in Table 1. Both laboratories developed analytical capabilities for chlorinated acid herbicides and base/neutral extractable compounds. In addition, the MDA laboratory developed analytical capabilities for aldicarb and performed these analyses for both departments.

RECOMMENDED DRINKING WATER LIMITS

Federal and State drinking water standards have been established for six pesticides. Only one of these chemicals, 2,4-D, is commonly used in Minnesota and included in the surveys. In order to address the public health concerns presented by the detection of pesticides in drinking water, the MDH established recommended drinking water limits for the remaining pesticides in the survey (Table 1). These recommended allowable limits (RALs) were established utilizing health effects data available from the U.S. EPA and other sources. The RALs were developed as health advisories, not as enforceable standards, and are subject to change as new and better health effects information becomes available.

WELL SELECTION

In general, wells were selected in agricultural regions and, within those regions, from areas where the local or regional soils and hydrogeologic conditions make the groundwater especially susceptible to pesticide contamination. Karst aquifers and shallow sand and gravel aquifers overlain by coarse-textured soils were viewed as particularly sensitive and most likely to show evidence of pesticide-related groundwater contamination.

The karst region in southeastern Minnesota is generally characterized by shallow depths to porous and permeable carbonate bedrock and, in some areas, by features such as sinkholes, caves and disappearing streams. These conditions can result in rapid transport of surface water containing dissolved or soilbound pesticides into the groundwater.

Shallow sand and gravel aquifers overlain by coarse-textured, low organic matter soils occur throughout the State and are particularly widespread in central Minnesota. These aquifers are comprised primarily of glacial outwash and alluvial deposits, but also include beach ridge deposits in northwestern Minnesota. The potential for pesticide movement to groundwater is increased in these areas because the soils typically allow rapid water infiltration and have a low capacity for adsorption of organic compounds. Irrigation, which is commonly practiced in many of these areas, may also contribute to the downward migration of pesticides. These sensitive areas are illustrated in Figure 1.

Other selection criteria were also used. Some wells were selected to provide areal coverage of the State's agricultural regions and diverse cropping patterns. The MDH selected several public drinking water wells based on historically high or fluctuating nitrates (greater than one milligram per liter) or on their proximity to bulk pesticide storage and handling facilities.

The MDA selected and sampled 65 water table observation wells which were originally installed by the Minnesota Department of Natural Resources or the United States Geological Survey. The typical observation well was completed in an unconfined, surficial aquifer and had a 1.25- or 2-inch diameter steel casing with a 2- to 3-foot sand point screen. Thirty-one private drinking water wells were used in areas (primarily southeastern Minnesota) where established observation wells were not available. Four high capacity irrigation wells and five tile lines were also sampled. The MDH selected and sampled 400 public drinking water wells (including 224 municipal wells) and 225 private drinking water wells.

SAMPLE COLLECTION AND ANALYSIS

Field samples were collected in 1-liter, amber glass bottles with Teflon-lined caps. Separate bottles were used to collect samples for chlorinated acid herbicides, base/neutral extractable pesticides and N-methylcarbamate pesticides. Samples were also collected for nitrate analysis on each sampling occasion.

Water samples were obtained after evacuation of three casing volumes of water or after operation of the well pump for 10-15 minutes. Observation wells were evacuated and sampled with a peristaltic pump or, in a few instances where water tables were deeper than the lift capacity of the pump, with a bailer. Prior to each sampling, the pump's silicone tubing or the bailer was rinsed with triple-deionized water and acetone. Samples from drinking water wells were collected at a point on the water supply system as near as possible to the well and prior to any treatment, if possible. All samples were immediately placed in insulated coolers, packed in ice and returned to the laboratory as soon as possible, usually within 72 hours.

Samples for chlorinated acid herbicide or base/neutral extractable pesticide analysis were extracted using standard methods and then analyzed by gas chromatography using capillary columns with different polarities and either nitrogen-phosphorus or electron capture detectors. In each of these procedures, a second column was used for confirmation. Samples for N-methylcarbamate analysis were extracted using standard methods and then analyzed by high performance liquid chromatography with post column fluorescence detection. Confirmation was performed by gas chromatography using capillary columns and nitrogen-phosphorus detectors. The N-methylcarbamate procedure was used primarily on samples collected near areas of probable aldicarb use.

Standard quality assurance/quality control practices were observed. Method blanks were analyzed daily to safeguard against contamination of glassware and/or reagents. Laboratory spiked samples were analyzed with each sample batch to monitor method performance. Field blanks accompanied almost all samples and were extracted and analyzed with the samples. Spikes and duplicates were each collected and analyzed with approximately 10 percent of the samples to monitor analytical accuracy and precision, respectively.

RESULTS

The results of the surveys indicated that several pesticides were present in groundwater, especially in hydrogeological sensitive areas of the State. The analytical results are presented in Tables 2, 3, 4 and 5 for the different survey phases.

In total, one or more pesticides were detected in 281 (39 percent) of the 725 sampled wells and in three of the five sampled tile lines. Sixteen pesticides, including fourteen herbicides, one insecticide and one wood preservative, were detected in the surveys. Atrazine was found in 266 (37 percent) of the sampled wells and was the most commonly detected pesticide in each survey phase. Alachlor and 2,4-D, the next most frequently occurring pesticides, were found in 40 and 13 of the sampled wells, respectively. Each of the remaining thirteen pesticides was detected in nine or fewer wells. Multiple pesticides were present in samples collected from 55 wells.

Although the percentage of wells with detectable levels of pesticides was relatively high, the concentrations detected were usually low. Eighty-three percent of all pesticide occurrences were at concentrations less than 1.0 µg/l. Levels exceeding the RALs were observed in samples collected from 16 drinking water wells, including five public wells and eleven private wells.

Pesticides were detected in wells in 51 counties. but were most commonly found in wells completed in karst formations in southeastern Minnesota, the shallow, outwash sand and gravel aquifers in central Minnesota and the shallow, alluvial sand and gravel aquifers in southwestern Minnesota. Few pesticide occurrences were observed in northwestern and south central Minnesota. Figures 2, 3 and 4 show, by survey phase, the sampling site locations and the pesticide detection status of each well.

Most of the 54 wells sampled by MDA in central Minnesota were in unconfined, surficial sand and gravel aquifers associated with outwash plains. These 54 wells included 45 water table observation wells, six drinking water wells and three irrigation wells. The median depth of the observation and drinking water wells was 23 feet with a range of 7 to 60 feet. The median water table depth of the observation wells (water table measurements were not available for the drinking water or irrigation wells) was 12 feet with a range of 2 to 42 feet.

Pesticides were detected in 34 of the 54 sampled wells. Wells in which pesticides were detected were examined with regard to well depth, water table depth and depth of the well beneath the water tables. Well depth was related to pesticide detections in that most of the detections occurred in wells less than 30 feet deep (Figure 5). A correlation was not observed between pesticide occurrence and water table depth or well depth beneath the water table.

MDH pesticide results for the private and public drinking water wells were evaluated on the basis of well depth, casing depth, and/or depth to bedrock. Well information was obtained from several sources including well owners/operators, MDH records, well logs and geological maps. Information on wells constructed in unconsolidated formations was usually not sufficient to permit a distinction between wells completed in surficial, unconfined aquifers and wells completed in buried, confined aquifers.

In most cases, private well information was limited to an owner-reported total well depth. For private wells completed in unconsolidated formations, the median well depth was 28 feet for wells with detectable pesticides and 40 feet for wells without detectable pesticides.

Casing depth was available for 179 of the 282 public wells completed in unconsolidated formations and was evaluated as a potential index of well vulnerability to pesticide contamination. Pesticides were found in 46 of the 179 wells. The median casing depth was 48 feet for wells with detectable pesticides and 72 feet for wells without detectable pesticides. The relationship between casing depth and pesticide occurrence is further illustrated in Figure 6. Pesticide occurrence was most common in wells with the shallowest casing depths and declined as depth increased.

Casing depth was available for 73 of 92 public wells completed in sedimentary bedrock. Pesticides were found in 25 of the 73 wells with casing depth information. Pesticide occurrence in these sedimentary bedrock wells did not appear to be related to casing depth. Pesticides were detected throughout most of the range of sampled casing depths.

Casing depth may be a poor indicator of water quality in sedimentary bedrock wells for several reasons. Wells with damaged casing or inadequate grouting may be drawing water from depths much shallower than the casing depth. In addition, well records and other geologic information indicated that most sampled wells were cased into the first bedrock encountered in drilling or into formations which were hydraulically connected to overlying bedrock. Under these conditions, there may be little impediment to downward migration of pesticides other than the overlying unconsolidated materials.

Results did suggest a relationship between pesticide occurrence and depth to bedrock (Figure 7). Pesticides were detected in 41 percent of the wells encountering the first bedrock at depths less than 100 feet, but in only ten percent of the wells encountering the first bedrock at depths greater than or equal to 100 feet. Pesticide occurrence did not appear to be influenced by depth to bedrock when that depth was less than 100 feet.

Table 6 illustrates certain observations in the MDH's repetitive monitoring of 25 private/public drinking water wells in the hydrogeologically sensitive areas of the state. The analytical results for atrazine at Well 1 are typical of the results for most of the wells in this survey phase. Atrazine was present at levels generally below 1 µg/l during most, if not all, of the sampling months.

Multiple pesticides, as represented by the analytical results for Well 2, were observed in 15 of the 25 wells during at least one month of the sampling period and peaked during May when eleven of 25 wells had multiple residues. Some compounds, including a few with rapid decay rates such as 2,4-D, were only observed for short periods.

Certain herbicides, as represented by the analytical results for Well 3, were detected in April prior to the spring pesticide applications. In some cases, these levels were at or near the maximum levels observed for that well during the sampling period. This data suggests that these herbicides persist throughout the year and may be leaching into the groundwater during the late winter or early spring recharge events. The high atrazine levels noted in April and August may indicate peaks associated with major recharge events.

NITRATE/PESTICIDE RELATIONSHIP

Nitrate-nitrogen analyses were conducted primarily to determine if there was a relationship between nitrate-nitrogen and pesticide occurrence in groundwater. If such a relationship existed, the relatively inexpensive nitrate-nitrogen analysis could be used as a surrogate for the expensive pesticide analysis.

A clear relationship between pesticide and nitrate occurrence was not observed in these surveys. Information on the occurrence of pesticides and nitrates in public drinking water wells is presented here for illustrative purposes. Only 82 of 187 public wells (43.3 percent) with detectable nitrate also contained detectable concentrations of pesticide. Pesticides were detected in 32 public wells in which nitrate was not detected, indicating that nitrate cannot be used as a reliable indicator of pesticide occurrence.

Survey results did indicate that pesticides occurred more frequently in wells with higher nitrate-nitrogen concentrations. Pesticides were found in 60.7 percent of public wells with nitrate-nitrogen concentrations greater than 10 mg/l, compared to a 17.4 percent pesticide occurrence in public wells with nitrate-nitrogen detected at less than 1.0 mg/l.

Nitrate data were also examined to see if there was a relationship between nitrate-nitrogen concentration and pesticide concentration. The data presented in Figure 8 shows no apparent relationship between pesticide and nitrate-nitrogen concentration.

The lack of a clear relationship between pesticide and nitrate occurrence in well water may be due, in part, to the respective sources of these compounds. While pesticides and nitrates may both occur in groundwater as a result of land-applied treatments, nitrates may also come from many other sources unrelated to pesticides, such as septic systems, animal feedlots or barnyards.

SUMMARY

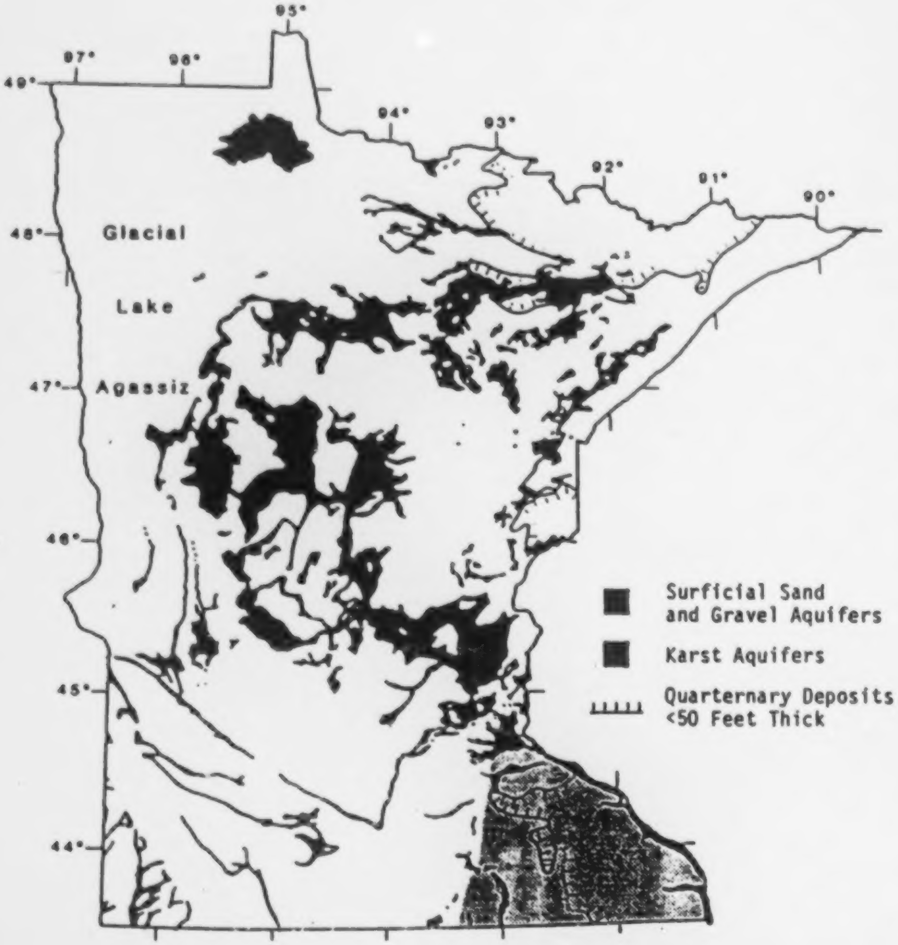
Certain pesticides were detected in Minnesota's groundwater and drinking water, especially in hydrogeologically sensitive areas of the State. Although the percentage of wells with detectable levels of pesticides was relatively high, the concentrations detected were usually low. The widespread occurrence of pesticides, primarily atrazine, at low concentrations in certain areas, and the presence of pesticides in observation wells located near field application sites, indicate that groundwater contamination may result from normal pesticide use as well as from point sources of contamination.

While pesticides were observed more frequently in wells in certain areas of the State, the potential for contamination in a specific well is determined by a complex set of factors, including the contaminant source, chemical properties, local groundwater vulnerability, local agricultural practices and well construction. These factors vary considerably from area to area and from well to well.

Nevertheless, the occurrence of certain pesticides in groundwater, the unknown human health implications resulting from exposure to low levels of pesticides in drinking water, and the many unresolved questions related to the complex movement and fate of pesticides in the environment raise significant issues which must be addressed. Additional monitoring, research, regulatory and educational efforts will be needed to minimize the impact of pesticides on water quality and public health.

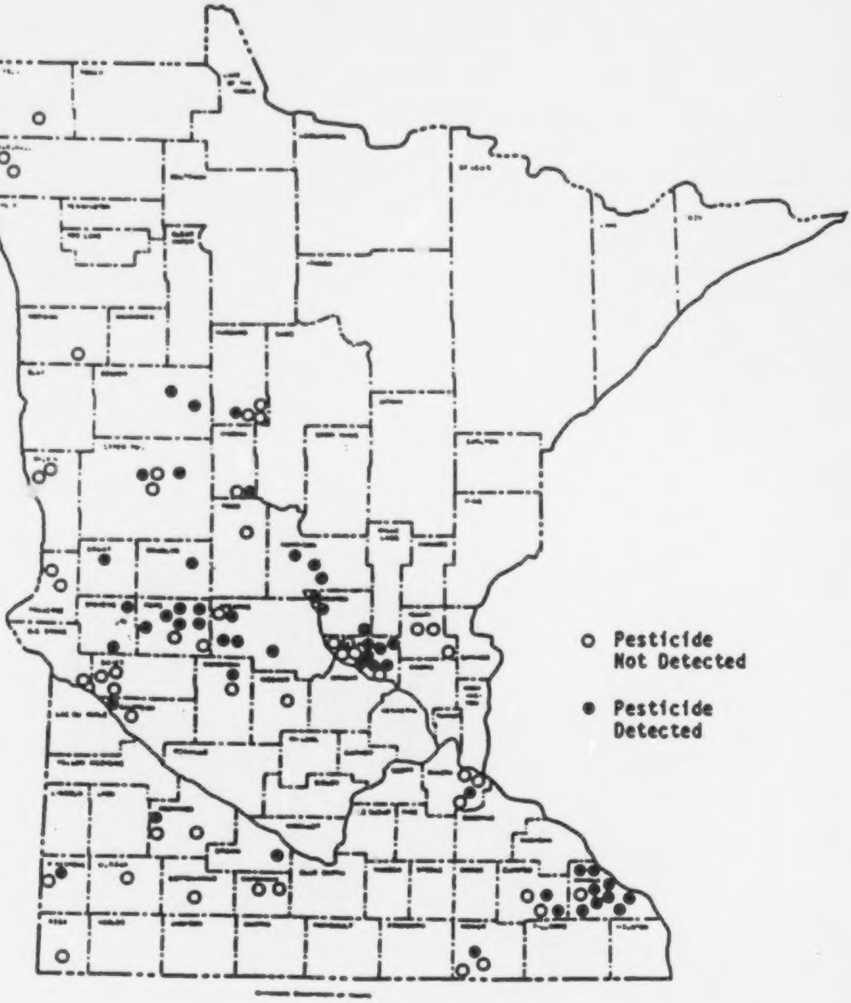
FIGURE 1

SURFICIAL SAND AND GRAVEL AQUIFERS
AND KARST AQUIFERS IN MINNESOTA


95°
97°
96°
49°
94°
93°
92°
91°
90°
48°
Glacial
Lake
47°
Agassiz
46°
45°
44°
Surficial Sand and Gravel Aquifers
Karst Aquifers
Quarternary Deposits <50 Feet Thick

Modified from H. W. Anderson, *In* Adolphson, D. G., J. F. Ruhl, and R. J. Wolf, 1981. *Designation of Principal Water-Supply Aquifers in Minnesota*. U.S. Geological Survey Water-Resources Investigations 81-51, 24 p.

FIGURE 2
OCCURRENCE OF PESTICIDES
MONITORING WELLS, MDA SURVEY



○ Pesticide Not Detected

● Pesticide Detected

FIGURE 3
OCCURRENCE OF PESTICIDES
ONE-TIME SAMPLING
PRIVATE WELLS, MDH SURVEY

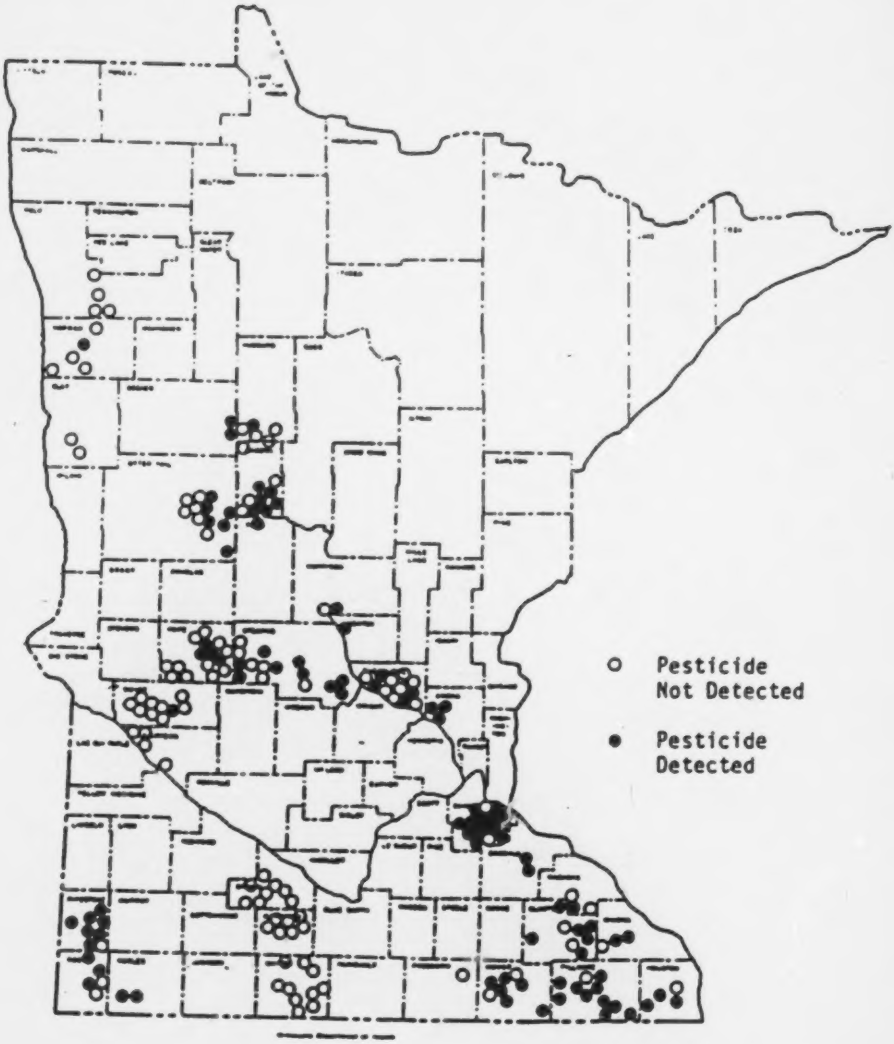

○ Pesticide Not Detected
● Pesticide Detected

FIGURE 4
OCCURRENCE OF PESTICIDES
PUBLIC WELLS, MDH SURVEY

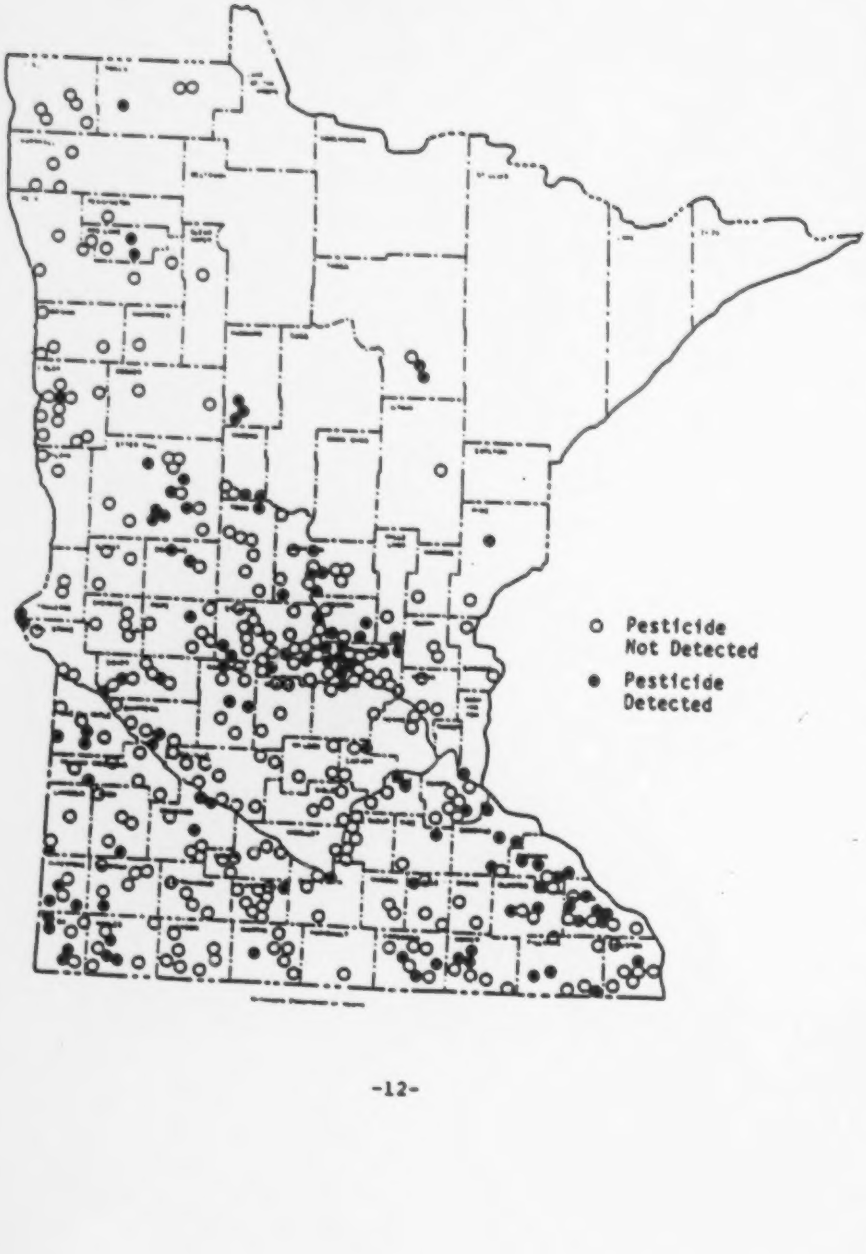

○ Pesticide Not Detected
● Pesticide Detected

FIGURE 5

FREQUENCY OF PESTICIDE OCCURRENCE VS. WELL DEPTHS
CENTRAL MINNESOTA

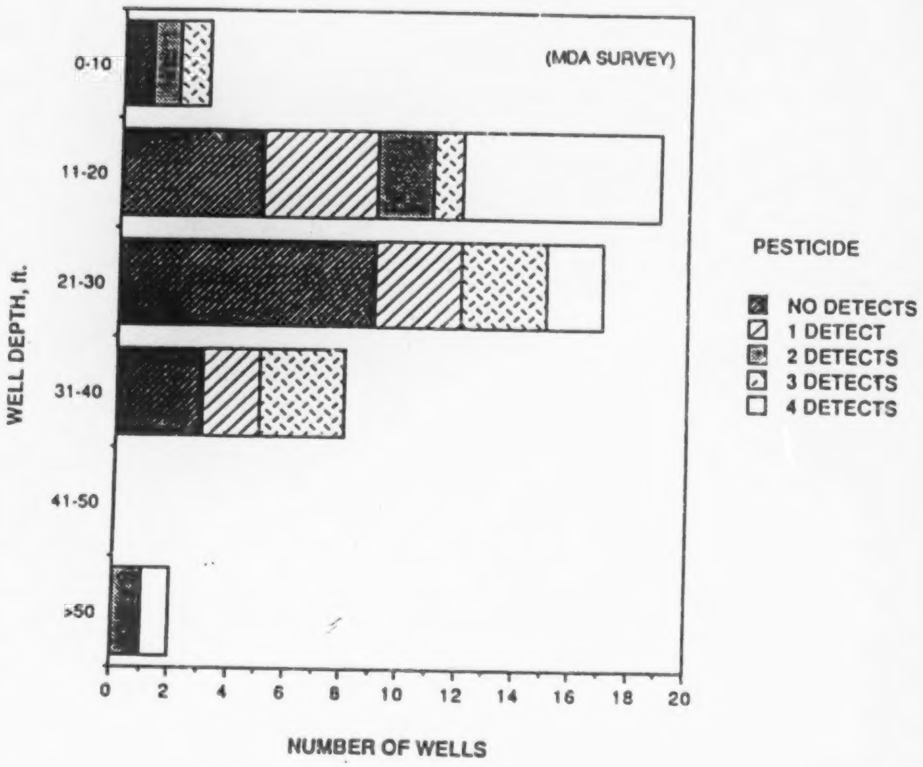


FIGURE 6

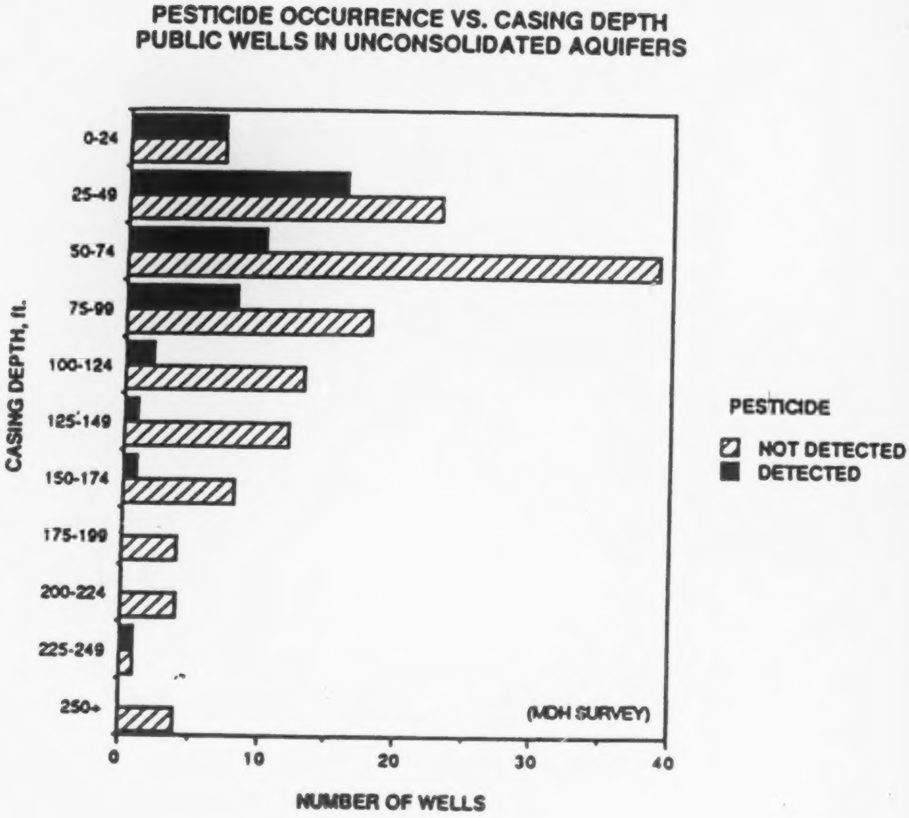

PESTICIDE OCCURRENCE VS. CASING DEPTH
PUBLIC WELLS IN UNCONSOLIDATED AQUIFERS
CASING DEPTH, ft.
0-24
25-49
50-74
75-99
100-124
125-149
150-174
175-199
200-224
225-249
250+
0
10
20
30
40
NUMBER OF WELLS
PESTICIDE
▨ NOT DETECTED
■ DETECTED
(MDH SURVEY)

FIGURE 7

PESTICIDE OCCURRENCE VS. DEPTH TO BEDROCK
PUBLIC WELLS IN SEDIMENTARY BEDROCK AQUIFERS

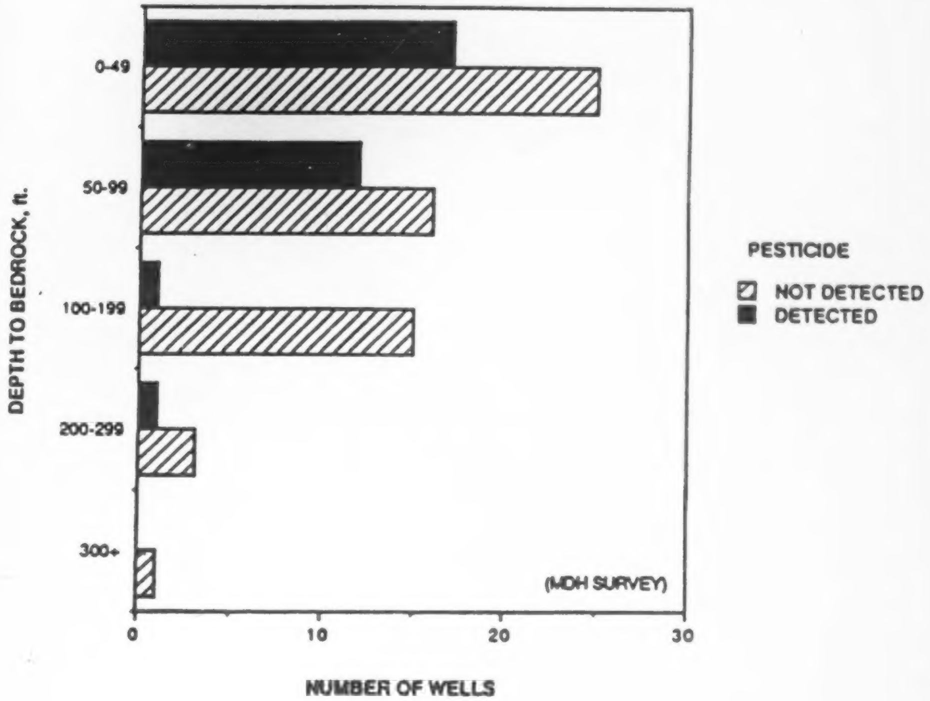


FIGURE 8

ATRAZINE CONCENTRATION VS. NITRATE CONCENTRATION PUBLIC WELLS

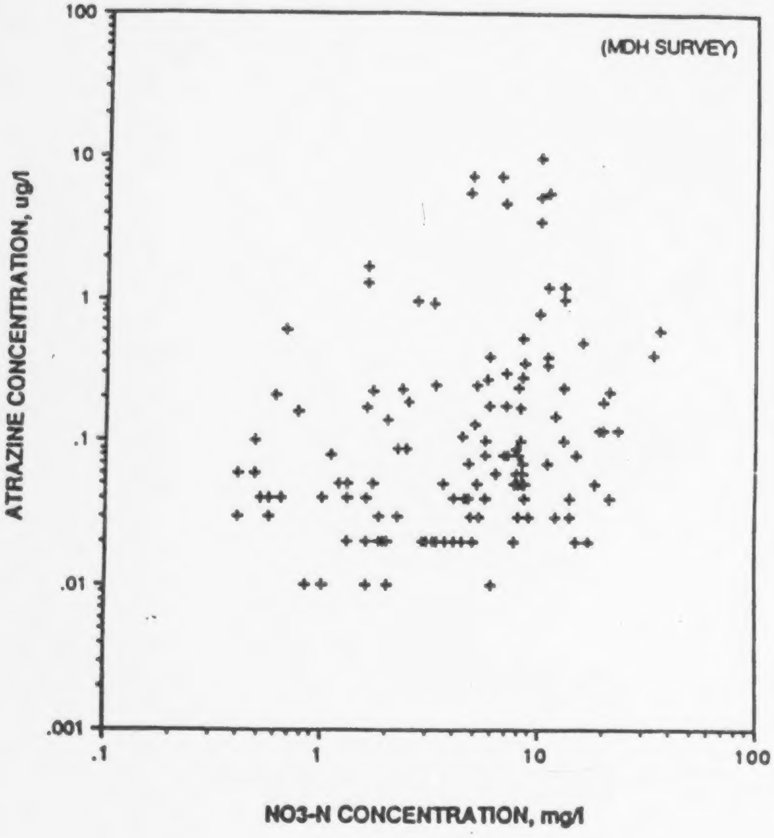


TABLE 1

PESTICIDE ANALYTES

Pesticide	MDA Reporting Limit (µg/l)	MDH Reporting Limit (µg/l)	Recommended Allowable Limit (µg/l)
Herbicides			
Alachlor	0.16	0.05	6.
Atrazine	0.05	0.01	3.
Butylate	0.79	0.01	50.
Chloramben	1.60	0.05	105.
Cyanazine	0.12	0.5	9.
Diallate	--	0.12	10.
Dicamba	0.18	0.04	9.
EPTC	0.24	0.01	35.
Linuron	0.17	0.4	44.
MCPA	0.27	0.05	3.6
Metolachlor	0.56	0.13	10.
Metribuzin	0.17	0.02	175.
Picloram	1.80	0.04	490.
Propachlor	0.10	0.2	92.
Simazine	0.08	0.3	35.
Trifluralin	0.02	0.03	2.
2,4-D	0.21	0.04	70.
2,4,5-T	--	0.04	21.
2,4,5-TP	--	0.05	10.
Insecticides			
Aldicarb	0.5	--	9.
Carbaryl	0.5	0.05	700.
Carbofuran	0.5	0.05	36.
Chlorpyrifos	0.24	0.05	21.
Dimethoate	--	0.2	140.
Disulfoton	0.82	0.45	0.3
Fonofos	0.16	0.03	14.
Methyl Parathion	0.10	0.02	2.
Phorate	0.49	0.10	0.7
Phosphamidon	0.70	--	--
Terbufos	0.26	0.2	0.18
Fungicides			
PCNB	--	0.02	49.
Pentachlorophenol	0.28	--	220.

TABLE 2

OCCURRENCE OF PESTICIDES
MONITORING WELLS, MDA SURVEY

Pesticide	Wells with Detections*	Samples with Detections	Median (µg/l)	Range (µg/l)
Atrazine	47	112	0.38	0.01-42.4
Alachlor	6	9	0.37	0.16- 2.81
Metribuzin	4	4	0.41	0.12- 0.78
Cyanazine	3	3	0.22	0.18- 2.90
Simazine	1	4	1.40	0.49- 2.58
Dicamba	1	4	0.66	0.53- 0.86
Aldicarb	2	5	9.0	0.50-30.6
Pentachlorophenol	3	3	0.58	0.42- 0.64

*One or more pesticides were detected in 51 (51%) of 100 sampled wells.

TABLE 3

OCCURRENCE OF PESTICIDES
ONE-TIME SAMPLING
PRIVATE WELLS, MDH SURVEY

Pesticide Name	Wells with Detections*	Median (µg/l)	Range (µg/l)
Atrazine	88	0.15	0.01 - 13.9
Alachlor	15	0.17	0.05 - 4.39
Metolachlor	4	1.25	0.14 - 2.1
Picloram	3	0.09	0.03 - 0.13
Dicamba	2	1.11	0.13 - 2.1
Propachlor	2	0.39	0.27 - 0.52
Metribuzin	1	0.72	N/A
2,4-D	1	4.2	N/A
Cyanazine	1	0.50	N/A

*One or more pesticides were detected in 92 (46%) of 200 sampled wells.

TABLE 4

OCCURRENCE OF PESTICIDES
TIME-SERIES SAMPLING
PRIVATE/PUBLIC WELLS, MDH SURVEY

Pesticide	Wells with Detections*	Median (µg/l)	Range (µg/l)
Atrazine	24	0.20	0.02 - 31.4
Alachlor	9	0.90	0.08 - 9.76
2,4-D	5	0.21	0.09 - 0.44
Propachlor	2	0.25	0.20 - 0.30
Metolachlor	2	0.51	0.15 - 2.40
2,4,5-TP	2	0.18	0.10 - 0.26
Dicamba	1	0.05	N/A
Metribuzin	1	0.05	N/A
Picloram	1	0.12	N/A

*One or more pesticides were detected in 24 of 25 sampled wells.

TABLE 5

OCCURRENCE OF PESTICIDES
PUBLIC WELLS, MDH SURVEY

Pesticide	Wells with Detections*	Samples with Detections	Median (µg/l)	Range (µg/l)
Atrazine	107	177	0.06	0.01-9.70
Alachlor	8	14	0.44	0.07-4.03
2,4-D	7	12	0.22	0.07-5.70
Dicamba	3	6	0.10	0.05-0.21
Picloram	3	5	0.16	0.08-0.63
MCPA	2	4	0.26	0.13-2.20
Metribuzin	2	3	0.23	0.10-1.05
Metolachlor	2	2	0.42	0.30-0.55
Propachlor	2	2	0.35	0.20-0.50
Cyanazine	1	1	0.80	N.A.
EPTC	1	1	0.33	N.A.
2,4,5-T	1	1	0.21	N.A.

*One of more pesticides were detected in 114 (28.5%) of 400 sampled wells.

TABLE 6

OCCURRENCE OF PESTICIDES
TIME-SERIES RESULTS (µg/l)
SELECTED PRIVATE WELLS, MDH SURVEY

Well	April	May	June	July	August	September	October	January
1	atrazine 0.23	atrazine 0.51	atrazine 0.24	atrazine 0.27	atrazine 0.37	atrazine 0.32	atrazine 0.52	atrazine 0.36
2	no sample	atrazine 0.02	atrazine 0.03	atrazine 0.03	atrazine 0.03	atrazine 0.03	atrazine 0.04	atrazine 0.04
		alachlor 0.47	alachlor 0.30	alachlor 0.13	alachlor 0.08			
		metribuzin 0.05						
		propachlor 0.30						
3	atrazine 20.5	atrazine 3.70	atrazine 4.55	atrazine 3.60	atrazine 31.4	atrazine 8.69	atrazine 8.08	atrazine 15.0
	alachlor 2.16	alachlor 0.14						

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TESTIMONY
PRESENTED TO
SUBCOMMITTEE ON INVESTIGATION AND OVERSIGHT
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION

One Hundredth Congress
U.S. House of Representatives
August 11, 1988

Greg Buzicky, Chief
Environmental Quality Section
Minnesota Department of Agriculture

Prior to 1985, little was known about pesticide presence in Minnesota's groundwater. The Minnesota Departments of Health and Agriculture's cooperative survey conducted in 1985 to 1987, provided an initial perspective on the extent and concentration of pesticides in groundwater in susceptible regions of Minnesota. These results concerned both agencies. Although the concentrations were usually low, the percentage of wells with detectable levels of pesticides were relatively high in these susceptible regions. One or more pesticides were detected in 165 (33 percent) of the 500 wells sampled, but eighty-four percent of all pesticide occurrences were at concentrations less than 1.0 ug/l.

The surveys demonstrated the difficult and complex nature of the problem. Variations in pesticide presence and concentration existed with time and depth of the sampling point beneath the water table. Pesticides were observed more frequently in observation wells and private drinking water wells than in public drinking water wells. Atrazine, the most commonly detected pesticide in each survey, was found in 154 (31 percent) of the 500 wells sampled and in over 90 percent of the wells which tested positive for pesticides. Alachlor, the next most commonly occurring compound in each survey, was found in 17 wells. Each of the remaining thirteen pesticides was detected in seven or fewer wells. Fifteen other pesticides were not detected at all in the survey.

The awareness of pesticide presence in ground and drinking water in Minnesota is having a tremendous impact on farmers, agri-business and regulatory agencies in Minnesota.

Farmers are concerned. They are affected first and potentially to the greatest extent. Farmers in Minnesota view groundwater quality as an important issue and this is especially true in hydrogeologically susceptible regions. There continues to be excellent cooperation and a high degree of interest by farmers.

Farmers are anxious for the development of recommendations, information and regulations based on agronomic and scientific facts. To be accepted, these solutions must consider health, economic and agronomic factors at a bare minimum. Because of the obvious complexity and time constraints in the development of these solutions, many farmers are reacting according to their own common sense and evaluation. These reactions include modifications of amount, rates and use of pesticide products. Around the farm there are increased safety measures when mixing, handling and rinsing of pesticides. Unfortunately, the additional information necessary to answer questions that now exist and address the practical concerns of farmers is limited at this time. This problem needs to be addressed immediately.

In addition to farmers concerns, the agricultural businesses have concerns also. First and foremost is a concern about water quality.

There is also significant concern about over reaction, over regulation and misplaced blame and liability. There is a general confusion about the interpretation of health risk assessment data, regulatory responsibility at the local, state and federal level, and accurate interpretation of complex data related to this relatively new environmental problem. In addition, there is a practical concern about the investment of capital in preventative measures without a guarantee that the regulatory authorities will endorse those measures in the future or without the knowledge that state-of-the-art preventative measures will work.

Protection of water quality is one of the most important issues to be addressed by the Minnesota Department of Agriculture in the immediate future. Nonpoint surveys will be coupled with an increased ability to respond to pesticide spills and other incidents that may adversely impact water quality. Monitoring projects are underway that address aldicarb movement to groundwater, pesticide presence and atrazine concentration trends in hydrogeologically susceptible regions and area specific studies. In addition, monitoring studies of surface water and effects of pesticide container dump sites are being planned.

The Minnesota Department of Agriculture, the lead state agency with regard to pesticide regulation, is in the process of implementing the 1987 Pesticide Control Law Amendments. The amendments significantly broaden the Departments duties and responsibilities and included requirements to address pesticide impacts on water quality. In addition, the Department is actively participating in groundwater protection strategies currently being developed.

The role of the federal government is crucial to the solution of the complex environmental problems that face agriculture. Technical information on pesticides regarding environmental fate, health advisories and analytical procedures is necessary. It is inefficient and prohibitively expensive for states to develop this type of information. Information transfer between states needs to be facilitated so that research and information need not be duplicated. But there still is a need for federal agencies to support states efforts to conduct targeted surveys under local conditions. The EPA National Pesticide Survey is a good example of how a federal agency efforts can compliment states efforts. One area of research that is greatly deficient is in the area of regulatory concerns. Funds need to be directed to researchers to encourage developments of information that directly applies and supports regulatory problems.

In summary, pesticide impacts are a significant concern by Minnesota's farmers, agri-businesses and state agencies. Information, data and technology is lacking and needs to be developed as quickly as possible; and certainly the support role and active involvement of the federal government is crucial to the development of solutions to these problems.

TESTIMONY
BEFORE THE
HOUSE SUBCOMMITTEE ON INVESTIGATION AND OVERSIGHT
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
AUGUST 11, 1988

Good morning, Chairman Oberstar and members of the Subcommittee. My name is Marilyn M. DuBois; I am the Director of the Bureau of Pesticide Management for the New York State Department of Environmental Conservation. I have been asked to comment on New York State's current program with respect to groundwater protection, monitoring and management, and the need for Federal action to protect groundwater.

New York Regulatory Program

The Department of Environmental Conservation has the lead responsibility in New York for both pesticide regulations and protection and management of groundwater resources. New York State has had extensive experience with pesticide control for groundwater protection. In support of our responsibilities, the New York State Department of Health provides toxicology assessments and is responsible for community water supplies. The New York State Department of Agriculture and Markets represents the agricultural community, many of whom are pesticide users.

The Department has developed two programs for the comprehensive management of groundwater resources - the Long Island Groundwater Management Program and the Upstate New York Groundwater Management Program. These programs provide a systematic approach for protection of groundwater and prevention of contamination involving all levels of government. The programs are periodically updated to determine the level of implementation for the recommended strategies. I have brought a copy of these two documents for the Subcommittee's review.

The Department also has promulgated regulations which classify all fresh groundwaters to be protected as potable and applies the same ambient water quality standards and criteria for groundwater protection, whether the groundwater is a current or potential drinking water supply. The regulations also establish ambient groundwater standards for 83 substances and effluent discharge standards for 87 chemicals. These standards were developed in cooperation with the New York State Department of Health. The New York State Department of Health also has drinking water standards for certain chemicals, and an action level of 50 parts per billion for all other organic chemicals.

As major point sources of pollution are being brought under control, the Department has also developed a Non-point Source Management Strategy, identifying agricultural and urban stormwater runoff as high priority non-point source program needs. A non-point source management program is now being developed as required by Section 319 of the Clean Water Act. Implementation of this strategy will be a challenging undertaking not only for this agency, but for other State and local agencies as well. The issues are controversial and success of the strategy is vital to the public health and welfare.

Groundwater Monitoring

There are areas of the State, such as Long Island, where more extensive monitoring and regulatory activities occur, due to the high vulnerability of the groundwater which serves as the sole source of drinking water for millions of persons. Since the mid-70's, about 90 of approximately 1,000 major public drinking water wells on Long Island have been closed or restricted in use because of contamination from synthetic organic chemicals and nitrates. Private household drinking water wells have also been contaminated by synthetic organics, pesticides, petroleum products and nitrates. For example, contamination of eastern Suffolk County wells with aldicarb (Temik) have led to the installation of activated carbon treatment units on over 1,400 private household drinking water wells. There is currently concern with dachtol contamination in drinking water wells which may lead to additional regulatory action.

In upstate New York, 18 major aquifers serve as drinking water supplies for almost one million persons. The groundwater quality of most areas in upstate New York appears to be good. However, there is increasing evidence of significant groundwater contamination problems. The most significant upstate groundwater quality problem is organic chemical contamination. Thirty-three upstate public water supply wells have been closed due to organic chemical contamination; some have subsequently reopened. Petroleum products are the most commonly reported type of organic contamination of private household wells, and also cause public well closure. Pesticides have caused extensive groundwater contamination on Long Island and could also be a threat to upstate areas. High nitrate levels which are related to agricultural and domestic fertilizer use have been found in upstate wells.

Pesticide monitoring in the upstate area occurs on a limited basis. As a condition of the Department's 1986 emergency regulation allowing aldicarb use on potatoes in upstate New York (aldicarb is only allowed for nursery/ornamental use in upstate New York and prohibited from use on Long Island) Rhone-Poulanc, the manufacturer, was required to conduct limited sampling of domestic wells on farms where aldicarb was used and also on a small field plot. The Cornell University Water Resources Institute conducted the sampling program for Rhone-Poulenc in 1987 and has issued a draft report on the results. The small field plot well monitoring continues to this day, and aldicarb residues continue to be found in a number of the special monitoring wells which are sampled on a regular basis by Rhone-Poulenc and reported to the Department.

Another special pesticide monitoring project resulting from the Upstate New York Groundwater Management Program, was conducted in upstate New York by the Cornell Water Resources Institute, in conjunction with the Department, between July 1985 and December 1987. There were 148 samples collected and anlyzed for alachlor, atrazine, carbofuran (and its metabolite 3-OH carbofuran), carbaryl, cyanazine, metolachlor and simazine. The final report is being prepared at this time.

The Department has also begun a pilot program to correlate pesticide use and groundwater contamination in at least one upstate county. Data on actual pesticide use will be used to direct a well sampling program for specific pesticides.

Federal Groundwater Strategy

The Department appreciates the difficulty in designing and implementing a prevention-based groundwater program, particularly at a national level. However, the strategy proposed by the U.S. Environmental Protection Agency (EPA) in its "Agricultural Chemicals in Groundwater: Proposed Pesticide Strategy" presents many problems. A copy of our comments to Dr. Moore will be included with our written testimony. EPA proposes a vulnerability-based pesticide management scheme, which is implemented by usage bans or decreased or modified usage. The Department believes that rather than investing very significant financial and staff resources in up-front vulnerability mapping, only to sometime later face the issue of modified useage or alternative control recommendations, the greatest emphasis should be placed on non-chemical alternatives, integrated pest management, and education and outreach to pesticide users. There must be a stronger effort to put reduced, modified or alternative control recommendations in place and get this information to users.

There are serious flaws in the EPA DRASTIC model which has been developed to project groundwater vulnerability. In New York, there are distinctly different geologic regions, (virtually the entire state, excluding the Adirondack and Catskill mountains) which contain a heterogeneous distribution of higher and lower vulnerability areas. Therefore, no group of counties clearly stands out above other counties as warranting restriction of pesticide use. County-by-county pesticide control restrictions are both impractical and unenforcable in New York.

It appears that EPA is placing the predominant burden of managing pesticides for groundwater protection on states, while offering the states little more than Maximum Contaminant Levels (MCLS), generalized pesticide information and the threat that EPA may cancel registration of pesticides within an entire state if it does not follow the strategy notions of vulnerability-based county or sub-county pesticide controls.

The proposed strategy on aldicarb is an example of a very complicated strategy for states to prepare management plans (New York is one of the states identified). This is a precursor of strategies which EPA will use for each chemical which it identifies as a leacher, placing significant if not impossible regulatory burdens on individual states, and ultimately failing to improve groundwater quality or providing groundwater protection.

EPA must exert its regulatory authority to deal with the issue of pesticides known to leach to groundwater by developing a consistent national strategy. The program as proposed will lead to unequal impacts on the agricultural economies of different states. There must be a stronger commitment to integrated pest management and stronger efforts to recommend alternative non-chemical pest control methods, alternative chemicals and lower application rates. The issue of nitrogen fertilizers must be addressed, as these are principal contaminants in rural areas. Groundwater protection criteria are the foundation of any prevention-oriented program; action levels lower than the MCLS are necessary for adequate groundwater protection. The Department has not formally developed its recommendations for alternatives to the EPA strategy. Nevertheless, we do not support the policy to allow continued contamination of groundwater. Finally, EPA cannot expect states to carry out these responsibilities without additional funding to support the program.

Thank you for the opportunity to present these comments.

Mr. **Oberstar**. We are really on the frontier of knowledge about this issue. Your roles have been very significant here. The States, as Ms. DuBois said just a moment ago, have a role to play. That is an important role. That is a very, very important partnership role that all of us have to exercise together. I am very impressed with the level of expertise and the seriousness of purpose with which these experts are pursuing matters that do require a great deal of thoughtful attention.

Again, I want to thank you for being with us today.

Ms. **DuBois**. Thank you.

Mr. **Buzicky**. Thank you.

Mr. **Oberstar**. Let me call our final panel.

We do have a roll call vote in progress on the House floor.

I would like to call Mr. Rick Hind of the U.S. Public Interest Research Group; Minnesota State Senator Steven Morse, representing the National Farmers Union; Dr. Jack Early, President of the National Agricultural Chemical Association; Mr. Mark Maslyn, Assistant Director of National Affairs, American Farm Bureau Federation; and Mr. H. Martin Jessen, President and Chief Executive Officer of the Freshwater Foundation in Minnesota.

[Witnesses sworn.]

Mr. **Oberstar**. Thank you.

The subcommittee will stand in recess for 10 minutes.

[Recess.]

Mr. **Oberstar**. The subcommittee will come back to order.

We welcome our panel and apologize for the interruptions that have plagued us all day. This is constant with our committee work in the House. The House goes into session earlier as we come closer to the end of the session, and we have more votes. It does interrupt the proceedings and string them out. Sometimes you lose continuity as well, which is, again, a casualty of the floor process.

Let us begin with Mr. Hind of the U.S. Public Interest Research Group.

TESTIMONY OF RICK HIND, U.S. PUBLIC INTEREST RESEARCH GROUP, WASHINGTON, DC; DR. JACK EARLY, PRESIDENT, NATIONAL AGRICULTURAL CHEMICAL ASSOCIATION, WASHINGTON, DC; HON. STEVEN MORSE, MINNESOTA STATE SENATE, REPRESENTING THE NATIONAL FARMERS UNION; MARK A. MASLYN, ASSISTANT DIRECTOR, NATIONAL AFFAIRS, AMERICAN FARM BUREAU FEDERATION, WASHINGTON, DC; H. MARTIN JESSEN, PRESIDENT AND CHIEF EXECUTIVE OFFICER, FRESHWATER FOUNDATION, NAVARRE, MN; AND DIANE BAXTER, STAFF SCIENTIST, THE NATIONAL COALITION AGAINST THE MISUSE OF PESTICIDES

Mr. **Hind**. Thank you, Mr. Chairman.

My name is Rick Hind. I am an environmental lobbyist for the U.S. Public Interest Research Group. I will begin by taking excerpts from my testimony and give you the remainder for inclusion in the record.

We appreciate the opportunity to testify today on behalf of U.S. PIRG, Environmental Policy Institute, Izaak Walton League, National Coalition Against the Misuse of Pesticides, Clean Water

Action Water Project, National Toxics Campaign, Friends of the Earth, and Public Citizen's Congress Watch.

As you may remember, in 1962 Rachel Carson inspired a generation of Americans to a new level of environmental awareness. In her prophetic best selling book "Silent Spring," she warned, "there is probably nothing more disturbing than the threat of widespread contamination of ground water . . . As ground water and surface waters are contaminated with pesticides and other chemicals, there is a danger not only of poisonous but also cancer-producing substances being introduced into public water supplies."

Before this time, it was widely believed that pesticides could not penetrate our ground water. In fact, it was believed that the ground or the soils would somehow cleanse the chemicals in the soils before they reached ground-water levels.

Despite the enactment of a wide range of laws to protect the environment and public health since 1962—16 of which apply to ground water—virtually every American still risks the effects of exposure to some of the 2.6 billion pounds of pesticides used nationwide every year. For most of us, these chemicals come to us in the form of residues on our food or contaminants in our drinking water.

In terms of ground water, as we heard earlier, nearly half the United States population relies on ground water for drinking water. In rural America, that number is 97 percent of Americans in rural America who rely on ground water for drinking.

Ground water is a vast, unseen resource that is supplied through aquifers that behave very differently than surface water. It can be found at varying depths in the ground. It can move at speeds ranging from a few feet per year to miles per hour, in the case of underground caverns. As we have heard, it is a very complex resource that there is little knowledge about either locally or nationally.

Also amazing about ground water is that contamination can actually increase in wells or ground water after the source of pollution has been stopped. An example of this was pointed out by the State of California with the pesticide DBCP, which was increasing until a few years ago in the ground water of Fresno County, eight years after the chemical had been banned for use there.

Because ground water regenerates very slowly, its widening use for irrigation before and during the current drought will, no doubt, put pressure on the future supply and quality of rural drinking water.

As we now know from our experience with Superfund, once ground water is contaminated, it is very expensive to clean up. Superfund will spend about $8.5 billion over the next five years on mostly ground-water cleanup. Some of those sites, as you have mentioned earlier, will cost millions. Some sites will cost even hundreds of millions of dollars to clean up.

We also know that it is very costly to monitor or test ground water. A June, 1987 report by the U.S. Department of Agriculture's Economic Research Service estimates that the tests for just two pesticides in each of the 10.9 million wells at risk in the U.S. would cost between $900 million and $2.2 billion. Obviously, we face many different pesticides besides two as a threat. There are 13 million wells nationwide that people generally use for drinking water.

In terms of the extent of contamination, the USDA report talks about how 767 counties in the U.S. have a combination of vulnerable ground water and moderate to high pesticide use. These counties are located in every region of the country.

We recently analyzed files at the Environmental Protection Agency which contain over 100 reports on pesticide contamination of ground water. They showed that 73 different pesticides have been found in the ground water of 34 States, apparently due to normal pesticide use. Attached to our testimony are the details of the numbers of chemicals found in each State, and concentration levels where that is known.

These reports represent samples taken from approximately 45,000 of the Nation's wells. Contamination was found in 11,000 of these samples. Over 5,000 samples, more than 25 percent, exceeded health advisory levels.

Dr. Stewart Cohen, formally a scientist with the Environmental Protection Agency, testified before the Senate Agriculture Committee last April. He said, "I think it is reasonable to expect that several millions of people are exposed to pesticides in their drinking water."

As of April 1984, Dr. Cohen reports that 2,522 wells in California contain the nematocide DBCP exposing 700,000 people to this carcinogen there. He estimates that probably half of these wells exceeded action levels in California.

On Long Island, as we have also heard earlier today, due to the contaminant aldicarb, another nematocide pesticide, approximately 2,000 homes continue to have their water filtered at the expense of the chemical manufacturer. Suffolk County Department of Health Services estimates that the filtration will be necessary for decades to come.

In Iowa, another example, officials estimate that more than 25 percent of the population using public water supplies receives water that contains pesticides at some point during the year.

Recently, in regard to information or knowledge about pesticide contamination of ground water, one of the conclusions of a 1986 National Academy of Sciences report on ground water said that "the need for pesticide use data for ground water monitoring and protection programs, as well as for other environmental and public health purposes, restrictions in [the] current regulatory law and procedures on the public dissemination of such data may need reevaluation."

In other words, NAS was referring to the current statutory prohibition on the EPA to require agricultural producers to keep comprehensive records of pesticide use. This kind of black hole of information is intolerable.

Regarding EPA's proposed strategy for ground water, some might argue that this strategy will address many of these deficiencies. We strongly disagree. Although the Agency's strategy document recognizes that "enough information has been reported to indicate that the problem is widespread in certain areas of the country," it fails to prescribe appropriate solutions.

Environmental and public interest groups have criticized EPA's proposal for failing to use and establish health-based standards for pesticides in ground water. These groups also correctly criticize the triage approach to certain classes of ground water. This part of EPA's strategy would allow States to write off portions of aquifers for future consideration as drinking water sources. On all three of these points, the strategy is wholly lacking in prevention of pollution, the least cost alternative.

Regarding the threat to public health, we can't ignore the fact that the National Academy of Sciences reported last year that 90 percent of all tested fungicides, 60 percent of all herbicides, and 30 percent of all insecticides may cause cancer.

Of the 600 to 700 active ingredients in pesticides today, the EPA has set maximum levels for only 6 pesticides. As you alluded to earlier, there are over 40,000 products on the market, this does not even begin to address inert ingredients, nor the difficulty of monitoring for those ingredients as they travel with the active ingredient in ground water.

Although the number and extent of pesticide related chronic illnesses and latent diseases such as cancer has yet to be fully determined, we do know that widely used herbicides such as alachlor have been found in ground water. They have also been shown to be carcinogenic in laboratory studies.

A recent case-control study done by researchers at the National Cancer Institute found that farmers exposed to herbicides for 20 or more days a year had a sixfold increase in cancer.

DBCP, which we mentioned earlier, is also found in ground water of at least five States. It is also known to cause cancer, male sterility, damage to kidneys, lungs, and liver.

In Wisconsin, a study conducted by the Centers for Disease Control and the Wisconsin Division of Health found that women who drank water contaminated with low levels of aldicarb had already reduced activity levels in their immune system compared to women who drank water without aldicarb contamination.

Regarding solutions to contamination of pesticides in ground water, we bring your attention to a November 1986 public opinion poll conducted by the Iowa Department of Natural Resources which found that 84 percent of Iowans surveyed desired more stringent regulation of the use of pesticides. As you may know, Iowa and Nebraska have since enacted much stronger ground-water protection legislation.

When EPA's John Moore testified in the 100th Congress on pesticides in ground water, he emphasized the word prevention. We could not agree more that prevention is at the core of the debate on pesticides in ground water legislation as well as EPA's proposed ground water regulatory strategy.

Although the House Agriculture Committee's bill, H.R. 2463, contains a ground-water provision, it fails to establish ground-water guidance levels using fully health-based standards, such as the maximum contaminant level goals discussed earlier. It also fails to broadly define and therefore protect future drinking water sources.

In general, it is not a prevention bill, but a reaction bill that would allow carcinogens in the drinking water and would tie EPA resources up trying to "crystal-ball" the future uses of ground water. In fact, this bill would actually be a step backward in public health protection. It is not surprising that the bill has the support of the chemical industry.

However, last August, we want to compliment you, Mr. Chairman, for introducing H.R. 3174. We believe your bill helps to define ground water broadly. Consistent with the current practice at EPA's Office of Drinking Water, it also regulates pesticides using health-based standards. It allows for comprehensive monitoring and best management practices while giving the States a major role in developing their programs and funding to do it.

A reasonable dose of regulation and action now may save us from the day in which our ground water cleanup bill has grown to huge proportions and the general public has lost all trust in the chemical manufacturers, the pesticide users, and the system of government that purports to protect them. Surely, at that point, the options before us will be fewer.

Of course, amendments of FIFRA alone will not fully address the complex problems facing pesticides in ground water.

We have some other suggestions, because EPA has recently proposed the delisting of pesticide contaminated sites from its Superfund program, we feel Congress should clarify who is liable for clean-up of pesticides in ground water.

The Senate Environment and Pubic Works Committee may file its report this week containing a provision transferring cleanup liability from farmers to chemical manufacturers under certain conditions.

We further recommend that Congress look at realigning components of the farm policy to promote more environmentally sound practices.

Thank you for the opportunity to testify today. We look forward to working with this committee and trying to answer any of your questions.

Mr. **Oberstar**. Thank you very much, Mr. Hind, for your testimony and for the documentation that you have submitted in support of it.

Now we would like to proceed to Dr. Early.

Mr. **Early**. Thank you, Mr. Chairman.

We appreciate the opportunity to be here to participate with the committee. I have with me, immediately behind me, a couple of scientists who can assist in some questions. One is a toxicologist. The other is a ground water expert. Dr. George Rolofson, and Dr. George Oliver.

Mr. **Oberstar**. Should you wish to turn to them, we'll swear them in at that time.

Mr. **Early**. Thank you very much.

Mr. Chairman, I would ask your permission to have my written statement submitted as part of the record.

Mr. **Oberstar**. Without objection, it will be included in full.

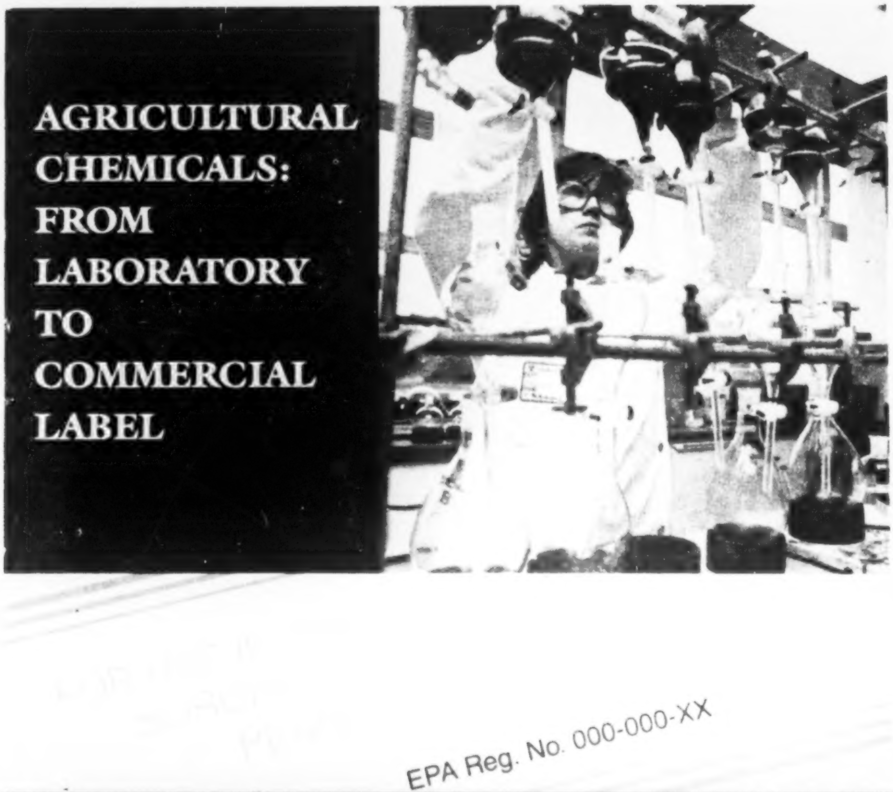
Mr. **Early**. With that request, what I would like to do now, if you will, is make a few observations and a few comments. Some are based on what we've heard today already, and some that I have reflected in our written statement.

Mr. **Oberstar**. Please, do.

Mr. **Early**. First of all, I would like to say, in our opinion—and I think most of EPA will agree with this—we know more about pesticides from a health and safety standpoint than we do of any other chemicals in our society today, both natural or manmade. The only possible exception where more extensive studies have been made is drugs. Even in the area of drugs, they are not as extensively evaluated from an environmental standpoint as pesticides are.

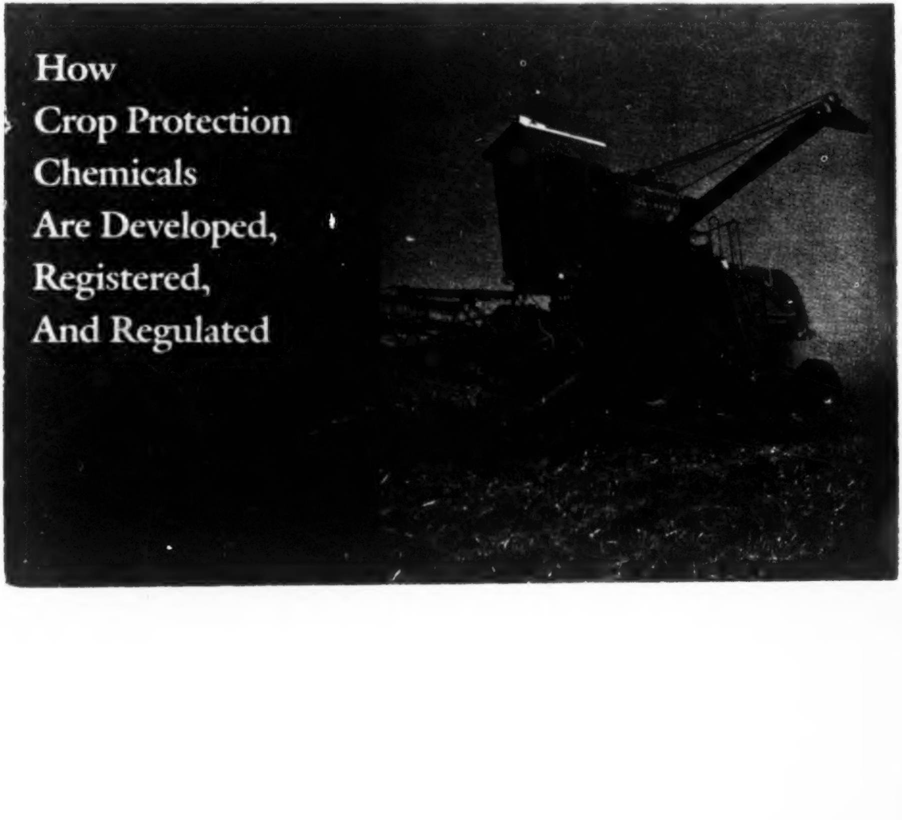
The requirements from the EPA before you register a pesticide today are extensive. I would like to put into the record a publication we have that shows how extensive those requirements really are, Mr. Chairman.

[Publication entitled "Agricultural Chemicals: From Laboratory to Commercial Label," follows:]



AGRICULTURAL CHEMICALS: FROM LABORATORY TO COMMERCIAL LABEL

EPA Reg. No. 000-000-XX



How Crop Protection Chemicals Are Developed, Registered, And Regulated

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FOREWORD

Federal law and the regulations and guidelines published by the Environmental Protection Agency spell out research requirements that must be met before proposed new crop protection chemicals can be put on the market. Regulations also establish criteria government scientists use to evaluate data submitted by the manufacturer.

This brochure describes the key steps in the process of developing an agricultural chemical and securing federal label registration. An application for registration of a new chemical for agricultural uses includes thousands of pages of detailed research data. Competent scientists in industry and EPA assure that agrichemicals can be used effectively, according to label directions, without causing unreasonable adverse effects to man or the environment.

Registration of a label by EPA is assurance that the product meets all requirements, that supporting data has been reviewed, and that the resulting conclusions have been accepted by qualified government scientists. Through this process, pest control chemicals are provided to help farmers produce more economical, high quality food, feed and fiber, and to protect valuable public and private property from destruction by insects, diseases and weeds.

INTRODUCTION

The United States abundantly feeds its own growing population, now nearly 230 million people, and still exports enough food and feed to supply millions of people in the rest of the world. With high technology, American farmers use latest farm machinery, follow modern management practices and utilize a variety of crop protection chemicals and programs. With these modern tools, farmers have nearly doubled production per acre since 1950.

Agricultural chemicals, agrichemicals and crop protection chemicals are some of the names used to describe chemical and biological products which, when applied in accordance with label instructions, control pests. In laws and regulations they are called pesticides.

In the agricultural sense, pests are weeds, plant diseases, insects, rodents, bacteria and other unwanted organisms. They attack fruits, vegetables, cotton and grain crops; forests and other crops; as well as home lawns, flowers, shrubbery, shade trees and gardens.

Agrichemicals are very strictly regulated in the United States. The basic U.S. law regulating agrichemicals is the Federal Insecticide, Fungicide, and Rodenticide Act, FIFRA. First enacted in 1947, FIFRA put regulation of these chemicals under control of the U.S. Department of Agriculture. In 1970, this responsibility was transferred to the Environmental Protection Agency. Through major revisions to FIFRA in 1972, 1975 and 1978, Congress provided an increasingly comprehensive regulatory system. All the data required for each agrichemical must be thoroughly evaluated by EPA scientists and staff before a label registration is granted to the applicant. Only then can the product be marketed legally.

This booklet is dedicated to a better understanding of the complex process of research, development and review leading to the registration of a new agrichemical product.

The flow diagram herein (centerfold) outlines typical basic components and the time frame required for registration. However, each agrichemical is unique in its composition, characteristics and intended use; so the detailed steps within the regulatory process may also be unique for each product. While specific steps to label registration may vary from product to product, they will vary within the framework discussed here.

EARLY RESEARCH

Chemical Research

Ideas for new agricultural chemicals come from many scientific disciplines. Useful products have been developed from discoveries in such areas as organic chemistry (the study of carbon compounds); plant, animal and insect physiology (the study of living organisms); and microbiology (the study of microscopic organisms).

First, there must be a pest problem to be solved. When the problem is identified, the search for a solution may cover many areas. "Candidate" compounds may be selected from chemical libraries which are maintained by many major manufacturers. New compounds may be "designed" by scientists, drawing on their knowledge that certain molecular combinations are likely to have specific, desirable effects. The scientist theorizes probable chemical structures and searches until he has found one that may exhibit the type of pest control activity desired.

Primary Screening

The initial stage in the testing process is called "primary screening." For this phase, the new compound is synthe-

Research greenhouse is used for primary screening to determine whether new chemical has desirable activity.

EARLY
RESEARCH

sized and produced in very small quantities. It is tested in the laboratory or greenhouse to determine its chemical or biological activity. Primary screening is performed with sophisticated laboratory equipment and detailed, often computerized procedures. It is designed to detect and assess the compound's ability to control one or several pests. In addition, other characteristics are noted for future reference in the chemical library.

Secondary Screening

Materials which show promise in primary screening undergo further tests called "secondary screening." Tests continue in the greenhouse and are expanded to small plots on a research farm. Such farms are maintained by most agricultural chemical companies and by cooperating research organizations.

Secondary screening takes place on small, outdoor plots at research farm.

The purpose of these tests is to confirm that the compound does, indeed, control a pest or pests under nonlaboratory conditions. The product is applied at varying rates and with differing application techniques to determine its performance in actual growing situations. The tests also reveal any effect that soil type, soil structure, rainfall and other field conditions may have on the compound's performance.

Toxicology Screening

One of the first steps in the investigation of a new compound is determining its potential toxic effect on animal systems. These tests assure protection for the investigators who are conducting the early research on the compound. Preliminary tests determine the degree of hazard in the event the chemical is accidentally swallowed, spilled on the skin, splashed in the eyes, or inhaled. This early testing often includes an "Ames test,"[1] a quick, short-term bacterial screening test to determine whether the compound might cause genetic damage. Sometimes these preliminary studies reveal such a high degree of toxicity that the experimental product is dropped from further development.

If the early test results are promising, the more advanced toxicological studies required for label registration may be planned or even begun during this time.

Other Considerations

In addition to toxicology studies, the probability that the candidate compound will be granted a patent is initially explored. Potential markets and manufacturing processes are also researched while early screening is underway.

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[1] The Ames test is named after Dr. Bruce Ames, Department of Biochemistry, University of California-Berkeley, who developed it. The effect certain chemicals have on bacteria indicates whether they might have a mutagenic effect in long-term tests on animals.

THE DECISION TO COMMERCIALIZE

All this early research has one goal—to provide sound scientific information, the data upon which company management decides whether to attempt to commercialize the agrichemical compound. Management now must decide whether to commit millions of dollars and years of additional research to secure label registration for a new commercial product. Most compounds fail the initial evaluations for one reason or another. Indeed, it is estimated that 10,000 or more candidates enter the screening program for every product that emerges successfully.

In reaching its decision, management must have positive answers to questions about product adaptability, product safety, market size, and patent protection. And the questions about safety also must be answered to the satisfaction of EPA. Only when all the answers are favorable will the company proceed with efforts to develop an approved, marketable product for pest control.

Product Adaptability

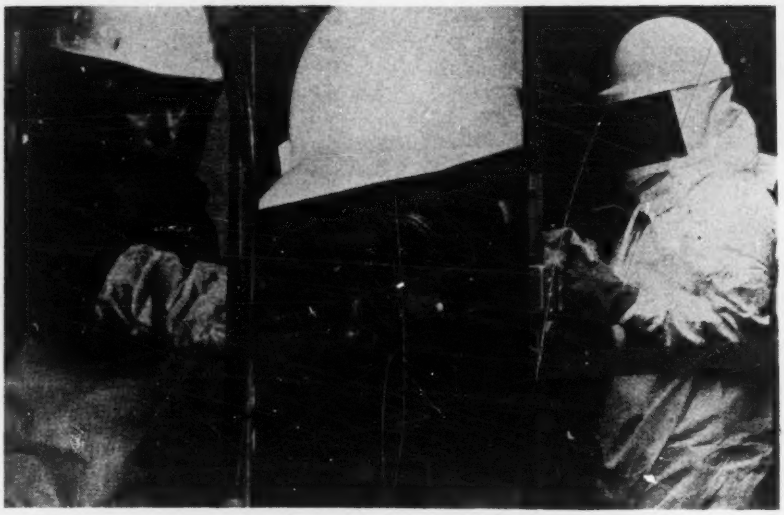
Will the product provide the necessary pest control within existing or new crop production systems?

Before an agrichemical can be marketed, it must be usable within an existing crop production system or adaptable to an existing application technique. For example, an insecticide to control insects on cotton should be suitable for application by aircraft, one of the application techniques used for that crop. In addition, before EPA can grant label registration, the label must list explicit application methods and rates, and instructions for use that allow the product to be utilized within the constraints of good agricultural practice.

Safety Considerations

Can the product be used without harming the user, damaging the treated crop, or having an unreasonable adverse effect on the environment?

The safety of the people who come into contact with the product during its manufacture, handling or use is of paramount importance. In developing adequate safety precautions, management will consider the need for protective garments, safe handling of equipment, limitations on re-entry of farmworkers into treated fields, labeling and warning statements, and safety training. The primary objective is the proper and safe handling and use of the product in the laboratory, factory and field.



Toxicology testing comes early to assure protection for laboratory personnel and others working with new compound.

Market Size

Will the market be large enough, and can the product be manufactured at a cost low enough, to make its development worthwhile?

Deciding to commercialize a candidate chemical means that the manufacturer ultimately may have to spend $30 to $40 million or more for its development. In addition, up to $100 million or more may be needed to build a new plant or remodel an existing plant to manufacture the chemical. Such costs keep most companies from commercializing a candidate compound unless potential sales are at least $40 to $50 million a year. This large market is necessary if the product is to regain its own cost of development, manufacture and marketing, and cover costs of research on the thousands of chemicals which did not "make it." Further, an adequate return on investment is needed to support future research to help meet the needs of the world's growing population. Because a large market is needed, companies usually can afford to develop new crop protection products only for such large-acreage crops as corn, soybeans, cotton and small grains. Specialty and very small acreage (minor) crops, such as strawberries or most fruits and vegetables, simply cannot support the tremendous costs of developing new agrichemicals. Protection for such crops must be provided through other registration mechanisms, discussed later in this booklet.

Patent Protection

Will patent protection give the manufacturer time to recover the cost of bringing the product to market?

Seventeen years of patent protection for a new product is established by federal law to encourage innovation. Patentability is a key consideration for the manufacturer in deciding whether to spend millions of dollars to commercialize a new product. Because numerous, time-consuming tests are required before a new crop protection chemical can be registered, it may take seven or more years from the time a chemical is first synthesized until it is registered and ready for sale. Much of the 17-year patent life has expired before the product reaches the market. If an adequate period of protection is not available, the manufacturer may not be able to recover his investment and generate a profit to support continued research and innovation.

PREPARING FOR REGISTRATION

Following the decision to commercialize a new product, the manufacturer (applicant) must begin the complex, long-term research program required to support registration of its labeled uses.

Long-term animal toxicology studies, looking for effects such as cancer, birth defects, or mutations, are begun in the laboratory. Under controlled conditions, test animals are fed the chemical in various doses for a lifetime, which may be from one to two or more years.

Field studies are conducted on research farms to investigate the behavior of the chemical under all pertinent crop and use conditions. In addition, potential environmental or public health effects are assessed. Scientists investigate persistence and dissipation of the compound in soil and water, potential exposure via volatilization or vaporization into the air, or movement of the chemical from the area where it is applied.

Experimental Use Permits/Advanced Field Testing

In the U.S., crops are grown in a wide range of soils and climate. A proposed new agrichemical must be tested under the various conditions in which it will be used. Large-scale field studies are conducted under an experimental use permit, EUP, granted by EPA. To secure the EUP, the applicant must submit a request for the permit, including data from tests conducted in the toxicology laboratory, in the greenhouse and from small test plots. The proposed test program and label for use also must be submitted for acceptance.

If the crops treated under an EUP are to be marketed, adequate health and safety data must be submitted to EPA with a petition requesting a temporary residue tolerance. If a temporary tolerance is not granted, treated crops cannot be used and must be destroyed. After scientific review, and a determination that the product as used in the proposed test program will not cause adverse effects and that it is suitable for the purposes intended, EPA will approve the experimental use permit.

Tests under the EUP involve application of the chemical on larger plots at research farms, often through the cooperation of state universities or land grant colleges, across the country. Farmers participate in conducting large-scale field studies under the direction of a responsible researcher. The USDA Agricultural Research Service also may cooperate in these studies to gain more information on new products. Private contractors, specializing in such studies, provide another source for objective evaluation of the candidate product.

An Experimental Use Permit allows carefully controlled trials of the new chemical under actual farming conditions.

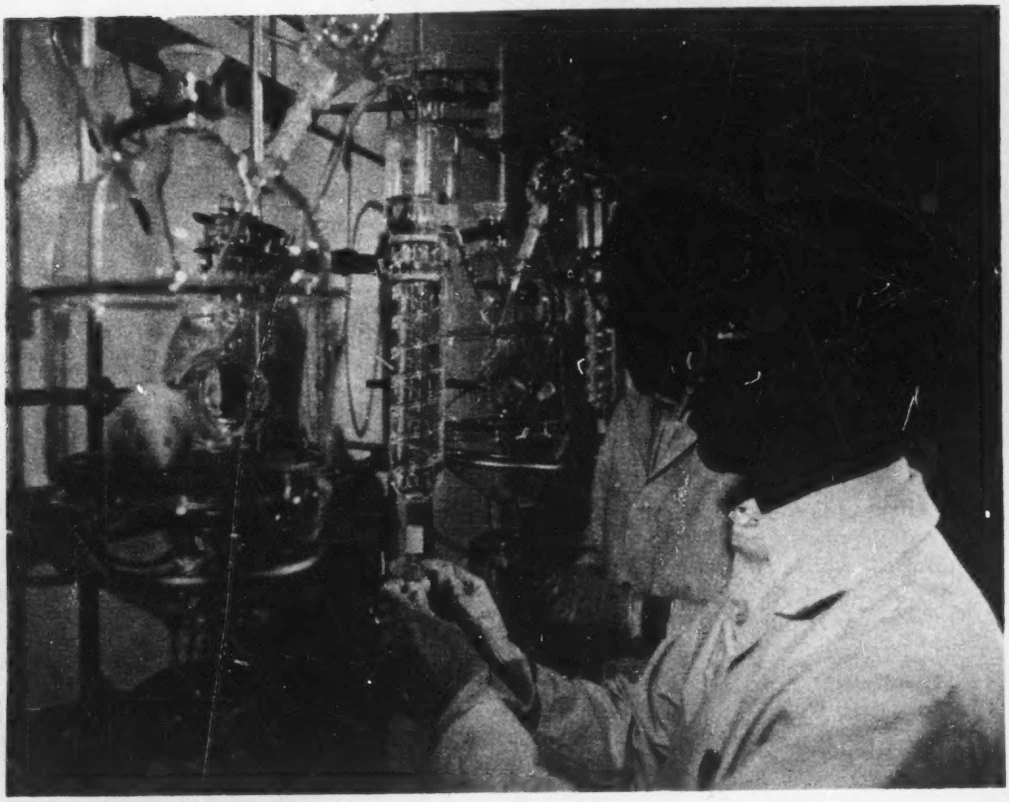
The studies are designed to determine safety to the treated crop and the effectiveness of the compound in controlling the target pest or pests under actual farm conditions. Also, appropriate rates, timing, methods and frequency of application are studied. In addition, chemical formulations and types of equipment for optimum delivery to the target site are evaluated by field researchers.

Field studies designed to provide residue data required for the establishment of permanent residue tolerances are carried out. Samples taken from test plots are analyzed. The presence and amount of the chemical and its breakdown products (metabolites) that can be detected in the edible portion of the crop are determined. In addition, researchers must determine the environmental fate of the compound by identifying the speed and manner in which it decomposes, or is dissipated or diluted into the soil, air or water.

Health and Safety Studies

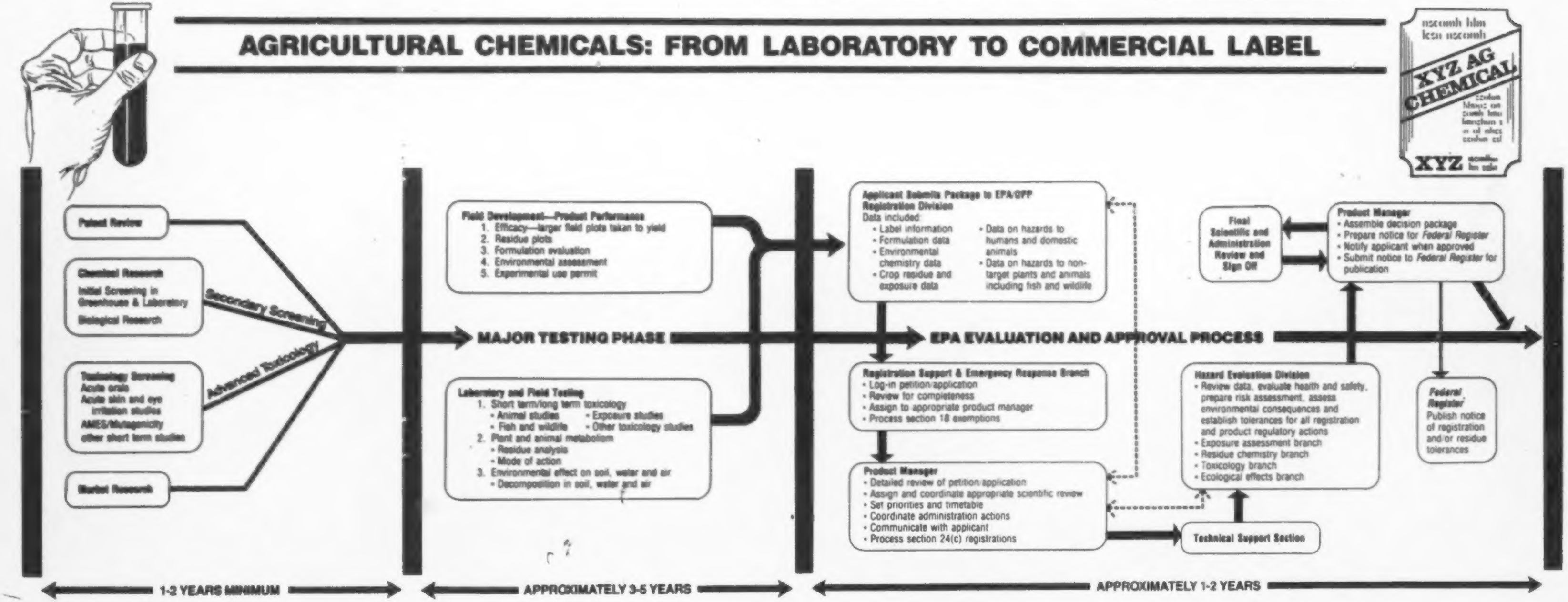
A primary requirement for the registration of an agrichemical under FIFRA is that its use will not result in "unreasonable" harm to man or the environment, in relation to the benefits of its use. Over a hundred studies will be performed in the laboratory or in the field to produce data

Long-term testing supports label instructions to protect users of agrichemicals.



AGRICULTURAL CHEMICALS: FROM LABORATORY TO COMMERCIAL LABEL

AGRICULTURAL CHEMICALS: FROM LABORATORY TO COMMERCIAL LABEL


XYZ AG CHEMICAL
XYZ
Patent Review
Chemical Research
Initial Screening in Greenhouse & Laboratory
Biological Research
Toxicology Screening
Acute orals
Acute skin and eye irritation studies
AMES/Mutagenicity
other short term studies
Market Research
Secondary Screening
Advanced Toxicology
MAJOR TESTING PHASE
Field Development—Product Performance
1. Efficacy—larger field plots taken to yield
2. Residue plots
3. Formulation evaluation
4. Environmental assessment
5. Experimental use permit
Laboratory and Field Testing
1. Short term/long term toxicology
• Animal studies
• Exposure studies
• Fish and wildlife
• Other toxicology studies
2. Plant and animal metabolism
• Residue analysis
• Mode of action
3. Environmental effect on soil, water and air
• Decomposition in soil, water and air
Applicant Submits Package to EPA/OPP Registration Division
Data included:
• Label information
• Formulation data
• Environmental chemistry data
• Crop residue and exposure data
• Data on hazards to humans and domestic animals
• Data on hazards to non-target plants and animals including fish and wildlife
EPA EVALUATION AND APPROVAL PROCESS
Registration Support & Emergency Response Branch
• Log-in petition/application
• Review for completeness
• Assign to appropriate product manager
• Process section 18 exemptions
Product Manager
• Detailed review of petition/application
• Assign and coordinate appropriate scientific review
• Set priorities and timetable
• Coordinate administration actions
• Communicate with applicant
• Process section 24(c) registrations
Technical Support Section
Hazard Evaluation Division
• Review data, evaluate health and safety, prepare risk assessment, assess environmental consequences and establish tolerances for all registration and product regulatory actions
• Exposure assessment branch
• Residue chemistry branch
• Toxicology branch
• Ecological effects branch
Final Scientific and Administration Review and Sign Off
Product Manager
• Assemble decision package
• Prepare notice for Federal Register
• Notify applicant when approved
• Submit notice to Federal Register for publication
Federal Register
Publish notice of registration and/or residue tolerances
1-2 YEARS MINIMUM
APPROXIMATELY 3-5 YEARS
APPROXIMATELY 1-2 YEARS

on acute (short-term),[2] subchronic (90 days)[3] and chronic (long-term)[4] effects, if any, on large and small animals, aquatic organisms, fish, and wildlife species. These studies will also produce the data on product, residue and environmental chemistry to identify chemical components of the product and its residue and environmental characteristics.

Chronic (long-term) feeding studies examine the compound's potential to cause cancer, birth defects, reproductive problems, mutagenic changes, nerve damage, or other toxic effects in test animals. In these studies, different groups of test animals are fed measured doses of the test compound throughout their lifetimes. Changes in their well-being are carefully monitored and compared to those in a control group of untreated animals.

In multiple-generation reproduction studies, treated animals breed and bear offspring. The ability of the test animals to reproduce and the characteristics and well-being of their off-spring are compared to those of untreated controls.

Determinations are also made on how the chemical moves into and through the animals' systems, how it is broken down and how it moves out of the animals' systems. With these clinical observations, the toxicologist can identify the dietary level of chemical exposure required to produce each toxic effect in each species of test animal. EPA publishes guidelines for the conduct of health and safety studies to assist researchers in the development of required data.[5]

Tolerance and Residue Studies

Tolerances are safe levels of an agrichemical which are allowed to remain in food for human consumption and feed for livestock, at the time the crop is harvested. In order to set these levels, data must be developed through field trials and toxicity studies.

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[2] Acute or short-term means one or more single exposures over a short time span; i.e., several days.

[3] Subchronic or 90-day means that the animal receives both toxic and non-toxic dosages or exposures over a 90-day period.

[4] Chronic or long-term means that the animal receives small exposures or dosages in its diet every day over its lifetime.

[5] For a detailed compendium of all safety and health studies required for all registration actions, see Code of Federal Regulations, Title 40, Part 158.

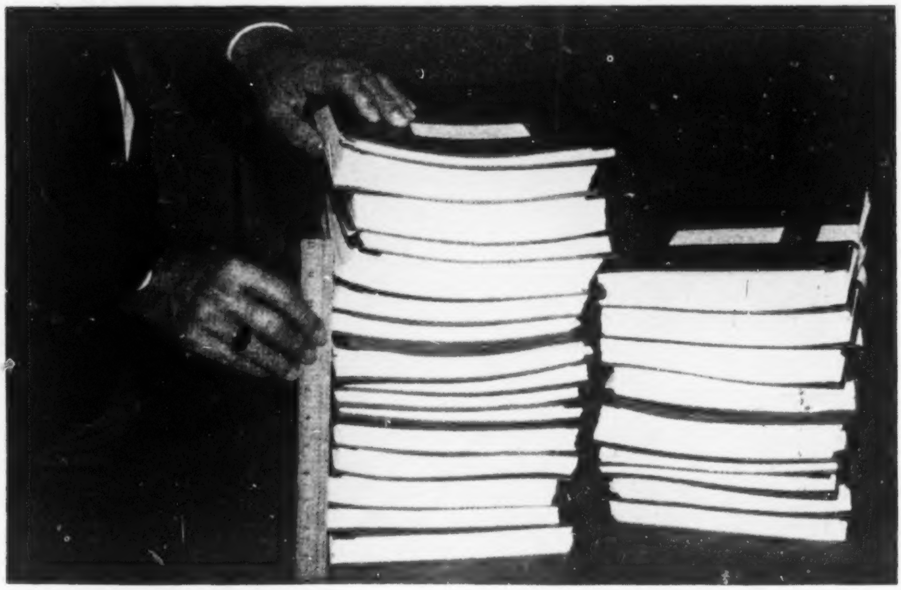
The residue levels in crops are determined from supervised field trials, using various rates, numbers of applications, and intervals between last treatment and harvest. The safety of the level is established through reproduction and long-term animal feeding studies, using various species of test animals. These toxicity studies determine the No Observable Effect Level, NOEL, the level at which the chemical has no harmful effect on the most sensitive test animal.

By dividing this NOEL by a safety factor of up to 100 or more, an Acceptable Daily Intake, ADI, is set. The ADI represents how much residue can be ingested by an average person every day for a lifetime without ill effect. Thus, the use of the safety factor means the legal residue is at a level far below that which has no effect on the most sensitive test animal.

Agrichemicals assure adequate supply of food; extensive testing assures that residue levels are safe.

THE REGISTRATION PACKAGE

At this stage, product development, including toxicology and advanced field testing, has taken approximately five to seven years to complete. All data resulting from these tests are then compiled into a registration package which may contain thousands of pages of research reports. This package is submitted to EPA to support registration of uses listed on the product label, as well as a petition for any necessary residue tolerances.



This "registration package"—18 volumes of scientific reports—was submitted to EPA to support registration of a new agrichemical.

Data to Support Label Registration

The applicant prepares a proposed label, along with supporting data for the new product, and submits it to

THE REGISTRATION PACKAGE

the EPA Office of Pesticide Programs (OPP)[6]. The proposed label identifies the pest or pests to be controlled and provides complete instructions for correct and safe use, handling and disposal of the product, as well as other information required by FIFRA. When accepted, the product label becomes a legal document. Use of the product contrary to the label is a violation of law.

The application for label registration is accompanied by the registration package, the compilation of detailed reports of the hundreds of studies conducted during the years of research. The package identifies the chemical and its formulation. It includes the petition for proposed residue tolerances, if any are required. Additional sections of the package itemize environmental chemistry, results of research on hazards to humans, domestic animals, nontarget plant and animal species including wildlife and fish, residue and metabolism studies and all other data required by law to support the label registration.

Analytical Procedures for Residue Detection

Residue tolerances are established by the EPA under authority of the Federal Food, Drug, and Cosmetics Act. When requesting a tolerance, the applicant must satisfy EPA's scientists that the proposed residue level will be safe. In addition, the petition for a residue tolerance must include a proposed method of analysis which will detect residues of the chemical in the raw agricultural commodity. This proposed analytical method is validated in government laboratories before the tolerance is established. The method is then used by the Food and Drug Administration to analyze random or selected samples of food or feed for the presence of illegal residues. (The U.S. Department of Agriculture monitors meat, dairy and poultry products for illegal residues.) If residues higher than those set by law are detected in the raw agricultural commodity, it may be seized and destroyed. Violators, in addition to loss of their products, may be subject to other legal penalties.

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[6] The EPA Office of Pesticide Programs is headed by a Director who is responsible to the Assistant Administrator for Pesticides and Toxic Substances. OPP is comprised of divisions such as Registration, Benefits and Field Studies, and Hazard Evaluation. Each division has branches which are assigned specific functions in the review process.

EPA EVALUATION AND ACCEPTANCE PROCESS

Internal Assignments

The registration package goes first to the Registration Support and Emergency Response Branch of the OPP Registration Division. Here it undergoes initial administrative processing, is screened for completeness and is assigned to a Product Manager in a particular Pesticide Registration Branch. The PM coordinates the required scientific and administrative reviews, sets priorities for review and develops a timetable for completion of the approval process.

The PM prepares a notice of receipt of the new chemical application, including any proposal to establish a residue tolerance, for publication in the *Federal Register*. The notice allows 30 days for comment from any interested person.

The health and environmental data for the new agrichemical is assigned to and reviewed by toxicologists, chemists, ecologists and other qualified scientists in the OPP Hazard Evaluation Division, HED.

Scientific Evaluation

HED has four specialized branches which conduct or oversee the scientific evaluation of the data submitted by the applicant. Reviewers in each of the four branches examine the manner in which the research in his speciality was planned and conducted, and how the applicant's scientists arrived at their conclusions.

1. The *Exposure Assessment Branch* evaluates how much of the chemical and its degradation products remain in the environment.
2. The *Ecological Effects Branch* uses the findings of the Exposure Assessment Branch to determine whether the chemical can adversely affect aquatic species (fish, shrimp, shellfish, etc.) and wildlife, and whether this poses any unreasonable problems.

Environmental research investigates effect of a new agrichemical on aquatic life as well as on vegetation and other wildlife.

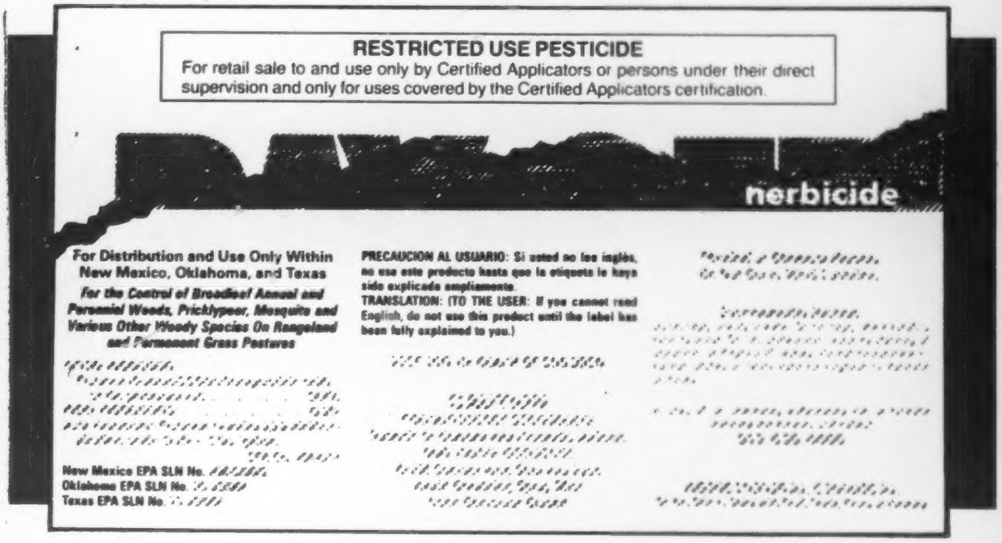
3. The *Residue Chemistry Branch* reviews residue data to determine how much, if any, of the chemical may remain in food crops or in the edible products (i.e., meat, milk or eggs) of various animals and poultry which may consume treated crops. It also reviews the level of residue tolerances proposed for each respective crop or use, and sends the data to the Toxicology Branch for evaluation.
4. The *Toxicology Branch* reviews all toxicology data to predict safe levels of exposure, assess risk, and determine if there will be potentially adverse effects on humans exposed to the agrichemical. These reviews are then compared with conclusions reached by the Residue Chemistry Branch. Thus, the two branches jointly determine whether the proposed use could potentially, through either direct or indirect exposure, cause harm to humans.

If some part of the data package is considered inadequate or the Agency's scientists determine more data is needed, the applicant is notified of the deficiency. The additional information must be supplied before registration can proceed and the label accepted.

Product Classification

Most farm chemicals and home and garden products used for pest control are general use products. They can be used by anyone who can follow label directions. However, a few products, because of acute toxicity or other hazards, may require special care and attention to assure that workers, the public, and the environment are protected from unacceptable exposure. These products may be classified for restricted use. Such products can be sold only for use by or under the supervision of a certified applicator.

Label clearly identifies a "Restricted Use" chemical. Such products can be sold to and used only by or under direct supervision of "Certified Applicators."



RESTRICTED USE PESTICIDE
For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for uses covered by the Certified Applicators certification.

herbicide

For Distribution and Use Only Within New Mexico, Oklahoma, and Texas

For the Control of Broadleaf Annual and Perennial Weeds, Pricklypear, Mesquite and Various Other Woody Species On Rangeland and Permanent Grass Pastures

New Mexico EPA SLN No.
Oklahoma EPA SLN No.
Texas EPA SLN No.

PRECAUCION AL USUARIO: Si usted no lee inglés, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.
TRANSLATION: (TO THE USER: If you cannot read English, do not use this product until the label has been fully explained to you.)

Certified applicators are farmers or professional, commercial applicators who participate in EPA-approved state training programs in agrichemical handling techniques and safety precautions, and pass a federally approved examination. Today, more than one-half of America's farmers are certified applicators. An applicator or farmer who violates label restrictions may have his certification cancelled. When this happens, the applicator can no longer buy or apply restricted use products on his own farm, or for customers.

EPA EVALUATION
& ACCEPTANCE
PROCESS

Decision to Register

Comments and conclusions from HED are returned to the Product Manager who compares the comments with the proposed product labeling. The PM weighs the results and recommendations of the scientific review, and the Agency decides whether to accept or refuse registration of the product label.

There may be occasions where certain minor studies to complete the total data package are still ongoing or have just been completed and have not yet been submitted. In such cases, if the Agency feels an adequate data base exists, a registration may be granted with the provision that the required data be submitted later on a schedule agreed to by the Agency and the applicant. This final submission then completes the data base.

Notification of Acceptance or Denial

When the product application is accepted, the PM prepares a final rule on the registration and any tolerance petition for publication in the *Federal Register*. If the application was changed by the applicant before it was accepted, the PM prepares a proposed rule, and allows 30 days for comment after publication in the *Federal Register*. Then a final rule is published. In either case, if there are no adverse comments on the tolerance petition within 30 days after publication, the regulation for residue tolerance becomes final and the regulatory action is completed.

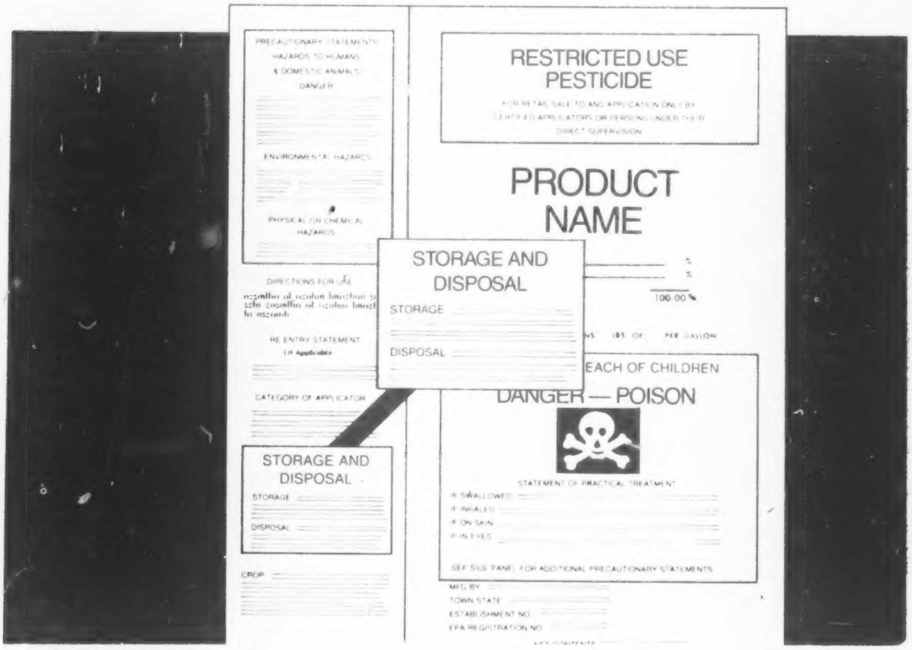
federal register
SECOND CLASS NEWSPAPER

Public notice of key regulatory actions on agricultural chemicals is given through publication in the Federal Register.

THE LABEL— THE LEGAL DOCUMENT

The result of seven or more years of research and development and up to two years of EPA review is an accepted label which can be placed on the product, allowing it to be marketed. The label reflects all the information which has been submitted to and accepted by the scientists and staff of EPA. It tells the user, in detail, how to store, handle and use the agrichemical for optimum control of the target pests, including precautions that must be taken to protect the workers, wildlife and the environment. In addition, specific use restrictions are provided to prevent the possibility of unnecessary residues in harvested crops.

The label describes the only legal uses of the product. It describes how the product must be handled and applied. Any deviation from the instructions on the label, except those provided by the law and EPA, not only ignores years of scientific effort but violates FIFRA, and is subject to legal penalties. To take advantage of millions of dollars spent to develop the new product, and to obey federal law, users must "STOP AND READ THE LABEL."


PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS
& DOMESTIC ANIMALS
DANGER
ENVIRONMENTAL HAZARDS
PHYSICAL OR CHEMICAL HAZARDS
DIRECTIONS FOR USE
RE ENTRY STATEMENT
(If Applicable)
CATEGORY OF APPLICATOR
STORAGE AND DISPOSAL
STORAGE
DISPOSAL
CROP
RESTRICTED USE PESTICIDE
FOR RETAIL SALE TO AND APPLICATION ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION
PRODUCT NAME
%
%
100.00%
LBS OF
PER GALLON
STORAGE AND DISPOSAL
STORAGE
DISPOSAL
EACH OF CHILDREN
DANGER — POISON
STATEMENT OF PRACTICAL TREATMENT
IF SWALLOWED
IF INHALED
IF ON SKIN
IF IN EYES
SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS
MFG BY
TOWN STATE
ESTABLISHMENT NO
EPA REGISTRATION NO

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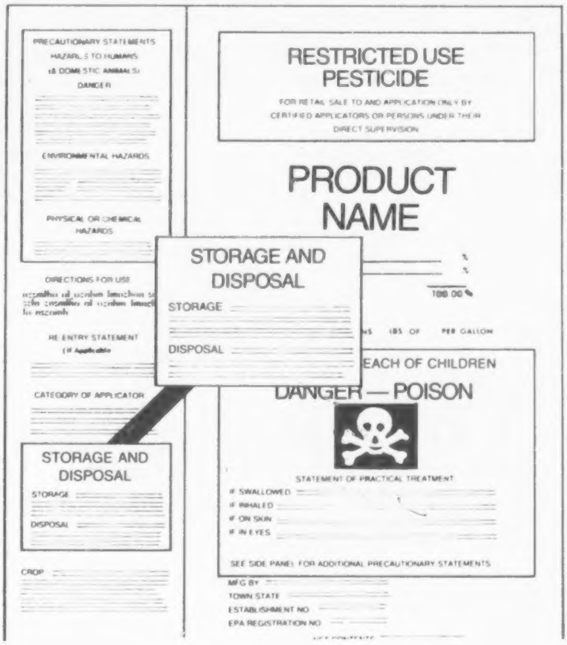
Federal law and regulations specify information which must appear on the label of all agricultural chemicals.


PRECAUTIONARY STATEMENTS
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FOR RETAIL SALE TO AND APPLICATION ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION
PRODUCT NAME
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STORAGE
DISPOSAL
100.00%
LBS OF
PER GALLON
EACH OF CHILDREN
DANGER — POISON
STATEMENT OF PRACTICAL TREATMENT
IF SWALLOWED
IF INHALED
IF ON SKIN
IF IN EYES
SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS
MFG BY
TOWN STATE
ESTABLISHMENT NO
EPA REGISTRATION NO

THE WORK CONTINUES

Label Expansion

The approved label marks the end of the first phase of the research, development and review process which is described here. It also marks the beginning of availability of a new product to protect food, feed and fiber crops from the myriad of pests with which humanity must compete for survival.

It marks the beginning of another phase—the beginning of the search for additional beneficial uses of the compound. Each new use added to the label, each new pest which can be controlled or each new crop which can be protected requires additional research by the manufacturer, additional review and acceptance by EPA.

Special Local Need (SLN) Registration

The process just described usually leads to registration of the product for use against major pests on major crops. Often the potential market for use of an agrichemical on small-acreage crops or localized pests will not justify the expense and time required to develop and register the compound. Thus, there may be no product registered for such uses, however important they may be to local farmers. FIFRA provides that such special local needs be met through Special Local Need, SLN, registrations.

An SLN registration may be issued by an individual state under the supervision of EPA. It can be issued only for an agrichemical which has an active federal registration and for which any necessary residue tolerance is established. It cannot be issued for a compound which is not currently registered by the EPA, nor for any use previously denied, disapproved or cancelled by the Agency. The agrichemical can be used for the special purpose only within the state granting the SLN registration.

Emergency Exemptions

Emergencies can arise in crop production. An unexpected insect, like the Mediterranean fruit fly, might threaten a crop or crops, or a new plant disease or weed might spring up for which no control is available. If no existing agrichemical is registered for use on the threatened crop or against the threatening pest, and EPA is satisfied that it cannot be controlled by any other means, an emergency exemption may be granted under Section 18 of FIFRA.

An emergency exemption may be granted only at the request of the governor of the affected state, the U.S. Department of Agriculture, or certain other federal agencies. EPA prescribes the conditions of use after considering all health and environmental aspects of the proposed use. It is granted only under the following highly restricted conditions: (1) only for a limited period of time (i.e., while the emergency continues); (2) for a precisely defined area; and (3) with rigid use restrictions. In addition, reports must be submitted to EPA on the progress of the emergency, the use of the chemical, and any results from using the chemical.

Emergency Exemptions are carefully controlled by EPA to protect crops from unusual pests.

CONCLUSION

The procedures described in this booklet have evolved over years of increasing knowledge and scientific sophistication. They are designed to meet society's desire for environmental quality, as well as humanity's need for an increasing supply of wholesome food. Through this process, science provides the crop protection chemicals needed to help people compete successfully in the contest against the myriad of pests which threaten the food supply for the growing world population.

Mr. **Early**. Following that, there have been some observations about the number of products that EPA is having to deal with. I heard you earlier today. We went from 40,000 down to a more manageable 600. If you look at that 600, far less than 600 are actually agricultural chemicals. A great deal of those products are products that are used in the home. The disinfectants and these kinds of products are all pesticides that must be registered with EPA, and also, the kinds of products that are used as algicides, and so forth, in cooling towers. These sort of things.

To put in perspective, we're talking about quite a few numbers less of agricultural chemicals to deal with than the 40,000 we started with today. So it's a little easier task, although still very difficult.

Another observation, too, is that we talked about parts per million, parts per billion, and parts per trillion. What concerns me in this whole discussion is that a lot of people are attempting to move us towards that goal of zero—and that is a very desirable direction to move into—I'm concerned that it's not an achievable goal.

When I first got into this business here in this area 20 years ago, the scientists at the Food and Drug Administration and the U.S. Department of Agriculture—before we had EPA—agreed that when we had a product that had a residue of something like 1 part per million, that was a toxicologically insignificant number. They considered anything less than that not to be considered at all.

Well, the analytical chemist has moved far beyond that now, Mr. Chairman. We're finding not only 1 part per billion, we're down to the parts per trillion. With their innovative knowledge, I'm sure that 20 years or 30 years from now we'll be able to determine one molecule. When we get to that point, we'll find 1 molecule of almost everything in our society almost anywhere you want to look for it.

So we've got to arrive at some practical place—negligible residue, "negligible risk," as we've talked about today. That's the direction that we see EPA going. We applaud them for doing that.

Another comment is that we've talked about the maximum contaminant level today. That's been used in a number of places. I think the thing that bothers me is that the public doesn't fully understand that when we establish a health advisory, or a maximum contaminant level, we're establishing it based on known toxicological data and a no-effect level. Then we added a minimum one hundredfold factor, and in some cases, a thousandfold factor to establish that number. My point is that when you hit that maximum contaminant level, or the health advisory, you're not at a high risk situation. You're at a trigger point where you should start looking at it, but you're not at any high risk at the hundredfold or thousandfold factor.

Another point—and I have some information with me that I'd like to share with the committee that you've heard about today—I really support strongly and can't emphasize enough the whole program and process of education and training of the American farmer, not only how he should use the product and manage the product, but how he should really get into integrated pest management, which our industry supports. That's really the direction to go. We think he's moving in that direction.

Mr. Chairman, and with your permission, I have samples of these kinds of bulletins and correspondence we've been using. I would like to submit those for your staff to have a look at. We can supply additional copies, if you would like.

Mr. OBERSTAR. We would appreciate receiving that. We'll include that in our committee file.

Mr. EARLY. Thank you.

[Materials retained in subcommittee files: Samples of NACA publications used in the education and training of the American farmer in the safe use of industry products.]

Mr. EARLY. Finally, Mr. Chairman, I'll make a comment that adds to—we heard Mr. Stangeland make a comment today regarding ground water legislation going through the process in the agricultural committee. He thought that that was the proper way to deal with this. The interesting thing about the ground water legislation that's working its way through the agriculture committee was one that started back in the 99th Congress. In the 99th Congress, this body, the House of Representatives passed that legislation three times. Within that legislation, there was ground water legislation that had been agreed to by my industry and some 41 environmental public interest groups. We thought it was good, solid legislation. We still support that legislation that's in the current legislation. Also, over in the Senate side, it's being looked at from the same standpoint.

So we're trying to address the issue. We recognized there was a problem. We're dealing with it, we think, in an appropriate way.

We thank you, Mr. Chairman. We'd be glad to respond to any questions.

Mr. OBERSTAR. Thank you very much.

I appreciate your testimony and the very important points you raised. We'll come back to those a little bit later.

We will call now on Senator Morse.

Senator MORSE. Thank you, Mr. Chairman.

I would like to voice my appreciation for being invited here today. Particularly, I'd like to thank you for your perspective approach as you look at this issue. I think that's the only way that we can deal with this issue as we look at remedial means to address the ground water contamination issue. It's too expensive, and it's too late, basically.

Let me give a little personal background of myself. I'm here today on behalf of the National Farmers Union. I am an apple grower from southeast Minnesota. We heard some discussion about our corner of the State where you have tremendous water quality problems. Our area is graced with beautiful geology that happens to be karst geology, thus meaning we're very prone to ground water contamination.

I am a second generation apple grower. If you know anything about apples, you know it's a very agricultural chemical intensive type of agriculture, especially in the midwest where we have a lot of moisture problems. As a result, I think the intensive use of chemicals in our industry has resulted in a rather intensive management of chemicals within in our industry also. I grew up during a timeframe when chemicals were the answer. When I was young, we used DDT. We found that that's no longer any good. Now we're finding some of the other chemicals we use are no longer any good.

Today I speak from the perspective of a farmer. After listening to the testimony today, I just feel that we've really moved beyond the point of where we just have to assess the damages. We have to start taking corrective action. We've seen plenty of testimony today already about the incidence of ground water contamination, particularly in Minnesota, but around the country.

The perspective of the farmer is that we feel we only have seen the tip of the iceberg from the experiences in talking to my farmers in Minnesota. There's a dramatic sense of urgency and a sense of anxiety amongst the producers in Minnesota, anxiety about what they're doing to their livelihood. As they affect their resources, their soils, and their ground water, it's not only their health, but it's their economic well-being.

It's almost as if there is a chemical dependency out there and that the farmers need some treatment that we tend to emphasize so much in Minnesota. The farmers I speak to are seeking options and alternatives. They're seeking education, resources, and people to turn to for options. In the last two years alone—since I was running for election in 1986—there has been a tremendous change in the attitude of producers.

I now have middle-aged farmers, who are mainline farmers producing corn perhaps 10 years in a row, approaching me and requesting me to see what we can do to ban chemicals across the board nationally. They tell me, we want to get away from chemicals. We don't know what we can do by ourselves. If we go off by ourselves, we're afraid we're going to have disastrous economic consequences. But if it were to happen across the board, at least we're going to save the environment. Then we would all be in the same boat. We think we would survive. That's getting to be a fairly common statement and a common sentiment. I think that is an indication of the change that we're seeing out in the countryside. The farmers desperately want to see a change in the direction of their agricultural policy.

I think I would be a bit remiss if I didn't touch on the question of nitrates in addition to the question of pesticides. Actually, there is kind of a gap in the regulation policy of the country in dealing with nitrates. I think it's a major problem.

I could give you examples of people who have lived on the farm for life and who have seen their wells go from being clean, in 1978, and after 10 years of corn, developing health problems within their families. They're testing their wells and seeing nitrate contamination levels up in the 40 parts per million. They are having to buy equipment to cleanse their water. In the past two years, as those farms in that area have gone into the CRP, and in the last year as the rest of the farms have gone in the set aside rate in that immediate area, we've seen the contamination levels drop back down towards the 10 parts per million, which is drinkable. We see contamination levels in the range of 14 parts per million.

Also on the point of the nitrates, we see in Garvenbrook Watershed—which is a project that's funded through the Rural Clean Water Project—we've had an 8-year study of testing up to 161 wells. About 38 percent of those wells tested in the last year exceeded 9.9 parts per million on the nitrates. Fully 75 percent of the wells tested exceeded 3 parts per million on nitrates. These are residential farm wells. So I think when we look at the concerns of the ground water, look at the nitrates. I think they're out there first. Then we see the pesticides coming along behind.

I feel that we can survey and discuss until we're blue in the face. What we have to do is take the long-term approach and look at new approaches. I believe that what we need is a frontal attack on the use of chemicals in the agricultural industry. As someone who uses chemicals, depends on them, and would lose our crop without them, yet I know that I can get by with a lot less. We have to go from a strategy of maximum production using chemicals to the promotion of maximum net and sustainability.

There was some discussion off low input agriculture. I believe that's the direction that we have to go. Just through training, education, and more conservative use of chemicals, I believe we can have a dramatic reduction in the number of chemicals that are applied and the affect that they have upon our groundwater resources.

What we need is sustainable agriculture that will make every attempt to minimize and reduce application and to sustain the resources, both of the land, the soil, and the water. Unfortunately, when I have community meetings or district meetings in my area, what farmers tell me is that they don't have the resources to back them up as they try to move in that direction. We have a number of nonprofits working in southeastern Minnesota with our producers to try to move them from heavy dependance on chemicals to more of an integrated, sustainable type of agriculture.

From what we've seen, the Extension Service has been diluted. It's no longer the Agricultural Extension Service, it's the Extension Service. It's now everything to everybody. We don't have the resources out in the rural parts of the country to answer the questions on basic items of agronomy, and soil. For too long we've been working with the manufacturers promoting use of chemicals to maximize production. I think the same problem continues to the university level where we see a significant amount, and in Minnesota—this is a ballpark figure—but in informal discussions, I believe the figure is approximately 7 percent of the research funding comes from chemical companies. To the best of my knowledge, that money is not flowing into programs that will reduce chemical application, but programs to look at how they can be used most effectively would perhaps be a better way to describe it.

In addition to clarifying the research dollars there, I also think that the Agricultural Research Service needs to look at more efforts and more money into researching areas to reduce the use of chemicals and, thus, also increase the profitability of farming.

I feel that the issue of chemicals in ground water is only one facet of the negative impact the chemicals can have. As much as I depend on them, as much as we need them, I think that we've over-emphasized them.

Some of the resolutions we can look at—I know there were questions earlier today about low input and sustainable agriculture in Minnesota. In reality, this year we've put more like $3 million directly into sustainable agriculture grants and programs to promote sustainable agriculture in Minnesota. The idea is to provide incentives for looking at options and taking the risk to get away from using chemicals to come up with new strategies. What's interesting and what's rewarding about it is that we're seeing this interest generate from the ground up. I was at a meeting last fall for our county where we had 100 and some people just to talk about low input agriculture. Farmers were getting up and saying, where can we get this information? We can't get enough information to satisfy our needs. We want to get away from this.

Other things that I think we should do at the Federal level, as well as what we're trying at the State level, is to look at the CRP program in a new light. We need to look at it as a second generation CRP where first we're concentrating on the protection of our surface waters and soils.

We have to look at using a program like that, if not the same program, for taking susceptible recharge areas out of agricultural production, or for limiting agricultural production in those areas. This has been an issue that has been near and dear to me. I've worked on legislation at the State to make our RIM program—which is similar to the CRP program—to make those areas that we identify as susceptible ground water recharge areas eligible for RIM payments to take them out of active agricultural production.

Earlier, we had discussion about counties, a county-by-county designation of what pesticides—I believe that was the context—can be used. I would caution that in our area it's not even township-by-township. It's ridge-by-ridge. We are in the process of mapping out the agricultural areas of the State completely by blue-line drawings—township quarter section-by-quarter section—of what soils are susceptible. We have a tremendous number of sinkhole fields which supply direct links into the ground water supply. In mapping those out, our objective will be to take some of those areas—hopefully, at some point, all those areas—out of production, or restrict uses of chemicals and restrict practices on those areas.

I'd also be remiss if I did not mention abandoned wells. Pesticide contamination occurs not only through leaching through the soils. In Minnesota, we estimate that we have 100,000 to 800,000 abandoned wells in the State. That gives you some idea of the magnitude of the problem when we can only come with an estimate in that range. We estimate that in Minnesota it would be a $200 million to $500 million cost just to seal the abandoned wells that we have in the State.

In conclusion, producers are anxious to address the problem and to be actively involved in resolving the problem. I believe strongly that the way we should address the problem of ground water contamination is through education and by providing incentives for producers to stop using pesticides either completely or in terribly vulnerable areas.

I believe that only by addressing the whole question of dependency on chemicals—and I include fertilizer and nutrients—can we ever address the problem of ground water contamination. As we talk about the various pesticides and the number of years we've been looking at them, we still have yet to identify so many of the problems. I believe the best that we can do is to back off and try to look at other options entirely.

I would encourage you to encourage the USDA to be actively involved in this process—and farm groups—to continue to work on the FIFRA legislation, an important part of this total picture.

Thank you.

Mr. OBERSTAR. Thank you very much, Senator. We greatly appreciate your statement as well as the spirit in which you have testified here today. Thank you, again.

Mr. Maslyn.

Mr. MASLYN. Thank you, Mr. Chairman.

On behalf of the Farm Bureau, I appreciate the opportunity to appear here before you this afternoon. I will summarize my remarks and ask that my entire statement be included in the record.

Mr. OBERSTAR. Without objection, so ordered.

Mr. MASLYN. Ground water, as we've heard all morning long, is a very important resource to agriculture. Over 90 percent of our rural residents rely on ground water as a source of drinking water. The potential for pesticide contamination is a matter of great concern and discussion throughout the agricultural community.

While farmers and ranchers agree that we need to protect this resource, there is also a concern that any such effort must recognize the vital role that agricultural chemicals play in modern farming practices. Farmers and ranchers would prefer not to use agricultural chemicals, but diseases, pests, and insects dictate otherwise. Until alternative methods of crop production become commercially practical, and until biotechnology products are available, we must be careful not to overreact so that the cure becomes worse than the problem.

I would also add at this point that the Farm Bureau has fully endorsed the IPM concept. We've encouraged our members to explore it. We're fully supportive of funding IPM programs at various State universities, implementing the pilot projects, and also the low input sustainable agricultural program that USDA is working on. We think those are two areas of great need and great interest out there among the farmers.

Mr. OBERSTAR. We compliment you on taking that stand and encouraging your membership to move in that direction.

Mr. MASLYN. Thank you.

Another reason that we must be careful in our response to pesticides in ground water is because of our limited knowledge of the scope as well as the causes and effects of the problem. Contrary to growing public perception, most pesticides do not leach. Furthermore, there appears to be increasing evidence that the causes of the problem is generally not the routine field application, but rather a point source factor such as shallow wells, unique pesticide characteristics, unique soil characteristics, improperly cased or cracked wells, or mixing and loading too close to wells.

I came across a paper by Dr. Richard Fawcett. The paper is titled "Pesticides in Groundwater: Defining the Problem." Dr. Fawcett is professor of agronomy, an extension weed scientist. He's also the coordinator of the pesticides ground water at Iowa State University. He and his colleagues put together this paper. I would like your permission to quote from it. I would ask that the entire paper be included in the record.

[The following was received from Mr. Maslyn:]

Mr. Masly -- For the record

Pesticides in Groundwater - Defining the Problem

Richard S. Fawcett

Several events combined to make pesticides in groundwater one of the most publicized issues in Iowa in 1987. Monitoring surveys revealed traces of certain pesticides (almost always herbicides) in some wells across the state. Many of these same pesticides had also been detected at certain times in groundwater in the Big Spring Study in northeast Iowa. Public fear about pesticide contamination has been increased by the lack of official drinking water standards and the perception that "nothing is known about the health effects of pesticides". Confusion between nitrate and pesticides further complicated the picture. In my opinion many misconceptions exist about how pesticides can contaminate groundwater. These misconceptions may have a very harmful effect on efforts to protect groundwater. In this article I will attempt to correct those misconceptions.

Based on early monitoring studies the Iowa Department of Natural Resources made several predictions and conclusions about groundwater contamination by pesticides. The Little Sioux River Survey Report states: "The results of the 1985 Little Sioux River Survey closely reflect the percentage of contaminated wells and public water supplies, 45 and 57 percent respectively, found in the 1984/85 SOC Survey. Based on the results of the Little Sioux River Survey, the 1984/85 SOC Survey appears to have been a representative sampling of groundwater quality statewide despite the fact that the sampling locations for the 1984/85 SOC Survey were not picked at random."

A conclusion of the 1984/85 SOC Survey by DNR was: "Research conducted by the Iowa Geological Survey over the past four years has shown that most of the pesticide concentrations in groundwater are derived through infiltration. Further, they have shown that the source of the contaminants is nonpoint in nature arriving in the groundwater as a result of widespread application to overlying fields. The results of this survey tend to support the findings of IGS in terms of the widespread nature of the problem, the concentration and distribution of pesticides in groundwater over time and the apparent systematic deterioration of shallow groundwater systems resulting from infiltration of commonly used pesticides." Apparently the "research conducted by the Iowa Geological Survey over the past four years" refers to the Big Spring Study and related studies conducted in northeast Iowa.

The Big Spring Study is a truly unique and comprehensive study which has greatly aided our understanding of groundwater contamination. Big Spring is located in Clayton County in northeast Iowa. The Karst typography in this area has numerous sinkholes which allow surface water directly to enter groundwater. The drainage basin of Big Spring has been meticulously documented through the use of tracer dyes. Thus the water which discharges from Big Spring represents water which has reached the shallow limestone bedrock in the entire 103 square mile basin. By sampling spring water at intervals and analyzing for pesticides, Iowa Geological Survey personnel have estimated total contaminants reaching groundwater in the basin. Unfortunately it is difficult to know how pesticides actually got into groundwater because they could have either run down sinkholes with surface water or infiltrated with normal use.

Other sources such as improper container, pesticide, or sprayer rinsate disposal, or backsiphoning could account for some of the contamination. The study's authors attempt to distinguish pesticides reaching groundwater by sinkhole runin by subtracting what came out the spring when the water was obviously muddy apparently due to runin events. Using this technique, the authors estimated depending on the year that from 53% to 84% of the atrazine reaching Big Spring got there by infiltration with normal use and not by sinkhole runin. This technique probably underestimates the importance of sinkholes, because soil containing pesticides is washed down the sinkhole, settles out, and can release pesticides later and runin water is dispersed through the system and could be discharged later. It is very important to note, however, that no pesticide other than atrazine was detected in Big Spring at times other than when rainfall caused surface water to run down sinkholes. As the Big Spring report itself says, "It is typical for the Big Spring basin that pesticide species other than atrazine are only found in groundwater during periods characterized by runin events."

Misinterpretation of the Big Spring study and the substitution of "pesticide" for atrazine in statements made about groundwater contamination have created a serious misunderstanding of the actual situation. This over generalization apparently accounts for DNR's statements about "the apparent systematic deterioration of shallow groundwater systems resulting from infiltration of commonly used pesticides", and statements to the effect that 80 to 90% of the pesticides in groundwater in Iowa got there by infiltration with normal use. DNR has also concluded that the Big Spring Study is representative of all of Iowa despite the unique topography with sinkholes, that point sources could not account for observed contamination in public wells because "concentrations resulting from spills would be much higher and, therefore, the contamination is a result of normal use of pesticides", and that "shallow groundwater systems may be affected at least for short periods of time by any pesticide".

Thus, the picture was painted that all pesticides leach with normal use, while other potential sources of groundwater contamination such as pesticide spills or improper disposal, sinkholes, or backsiphoning were relatively unimportant. Progress in protecting groundwater in Iowa will not be made unless we understand how contamination occurs and we attack the right causes. Misidentifying the causes of contamination could lead us to change practices in a way that could actually make contamination worse. A number of scientists across the country have concerns about what has happened in Iowa. An example is Dr. Phillip Kearney, head of the USDA Pesticide Degradation Laboratory, who oversees USDA-ARS research on pesticides in groundwater and states: "I have been afraid for some time that we are going to solve and regulate the wrong problem. I believe that we need to take a more holistic view of the groundwater situation and try to determine all of the sources, both point and non-point, contributing to groundwater contamination. Only then can we develop an intelligent national policy on pesticides in groundwater."

A great deal has been learned from research conducted across the nation in the last year, and the evidence more and more points to a different cause of groundwater contamination than that depicted by DNR. For certain persistent or highly mobile pesticides, infiltration with normal use does appear to be an important cause of detected contamination. Examples include leaching of Temik in sandy soils in Wisconsin and DBCP in

California. These products are not used in Iowa. As will be shown later, at least a part of the atrazine detected in well water in Iowa may be due to leaching with normal use. But for most of the other pesticides commonly used in Iowa a different cause of contamination is becoming clearer.

One way of studying pesticide leaching is to collect and analyze tile water. Presence of a pesticide in tile water does not necessarily mean that the product would move deeper to groundwater, but would at least indicate that it was able to move through 3 to 4 feet of soil. If pesticides are not detected in 3 to 4 foot deep tiles, they should not be able to reach deeper groundwater by leaching. Results of many tile studies are now available and the results are clear. Atrazine is the only common corn or soybean pesticide that can ordinarily be found in tile water. Rarely other products can be detected for very short periods of time under special circumstances. When heavy rains closely follow herbicide application, sometimes traces of a few other products can be detected in tiles soon after the rainfall, but then disappear. This short-term detection may be due to surface water bypassing the bulk of the soil through channels such as cracks, root channels or worm holes called macropores. But in routine monitoring of tile effluent or water in shallow monitoring wells under treated fields products other than atrazine are not detected. Studies in California, Iowa, Minnesota, and Maryland all show the same results. In the Upper Bluegrass Basin study in Audubon County conducted by Iowa Geological Survey personnel in 1987, no pesticides were detected in tile effluent except for a trace of atrazine in two tiles. Concentrations of atrazine in tile water have almost always been less than 1 ppb. The EPA Lifetime Health Advisory for atrazine in drinking water is 3 ppb.

Other studies support these findings. We have monitored a spring in eastern Iowa which is in a corn-soybean drainage basin, but which has no sinkholes which could allow surface water a direct access to groundwater. Throughout the growing season no pesticide other than atrazine has been detected. Atrazine can be detected at less than one ppb concentrations at certain times, but sometimes drops below detection limits (< 0.01 ppb).

Contrary to some observers' interpretations, the reason that atrazine is the most frequently detected pesticide is not because it has been used the longest or because it is the most popular. The reason it sometimes reaches shallow groundwater is due to its inherent physico-chemical and biological properties. It is persistent. Traces can leach below the root zone. Other products which have been used just as long or are as popular have not been detected in groundwater. For example, Treflan has been used almost as long as atrazine and is used on 60% of Iowa's soybeans. Yet it is not detected in groundwater. Despite the fact that Treflan is persistent, its low solubility and very strong adsorption to soil particles prevents leaching.

These recent tile and spring monitoring data would suggest that pesticides other than atrazine in groundwater should not be a problem in Iowa, except for areas where soils are very sandy or where surface water can directly enter groundwater. Still, we know that many wells across Iowa have measurable levels of pesticides other than atrazine. If these products do not leach significantly to tile depth under treated fields, how do they contaminate wells? The answer has been obvious for some time to many people who are familiar with how pesticides have been handled in the past. New monitoring data make the conclusions even clearer.

In 1986 the Iowa Legislature passed a law mandating that all public water supplies in the state of Iowa be tested for the presence of 35 pesticides and 35 other synthetic organic compounds (industrial chemicals, fuel components, and water chlorination by-products). Nearly all of Iowa's public water supplies have now been tested, and the results are extremely helpful in determining the most probable causes of contamination.

About 8% of all of the public water supplies which utilize only wells for their water source have had detectable traces of pesticides. This is considerably less than predicted by DNR based on their early surveys. As expected, surface water was more frequently contaminated, with 57% of the surface water systems testing positive for pesticides. Surface water running off treated fields early in the growing season will inevitably contain detectable traces of products that were used. Other synthetic organic compounds (not pesticides) have been far more prevalent, with over 50% of the public well systems contaminated and nearly all of the surface systems containing contaminants. Chlorination by-products such as chloroform were the most common contaminants. These by-products are formed when chlorine reacts with naturally occurring organic molecules. Chlorination is necessary to kill disease organisms, but the presence of chloroform in water is a concern since it is a known carcinogen.

But the most enlightening aspect of this survey comes from examining what pesticides are found where. Surface water systems, as expected, often contain traces of several commonly used herbicides which are moderately soluble, such as atrazine, Bladex, Dual, Lasso and Lexone/Sencor. Considering wells, if all pesticides leached with normal use, one might expect to find traces of the same list of products which are commonly used around a specific community in that community's well. If any product is found, one would expect to find atrazine first, because of the common pesticides used in Iowa, it has been shown to have the greatest potential to leach. Even a quick glance at the well monitoring data shows that this is not the case.

Atrazine and atrazine alone is sometimes found in wells. Usually these wells are in shallow sand and gravel aquifers along rivers. Trace levels of atrazine apparently are present in these aquifers. The presence of atrazine traces in the aquifer may be due to leaching with normal use or due to an interaction of surface water containing atrazine with the underlying sand and gravel. But many wells contain a single herbicide and not atrazine, despite widespread use of atrazine around the community. Certain wells have several herbicides, sometimes at unusually high concentrations (1 to 20 ppb). When we go out and look at well locations in these towns, invariably we find obvious potential point sources of contamination near one of the town wells: pesticide mixing and loading and storage areas.

The soil normally holds pesticides until they naturally degrade. Soil is an effective filter for most pesticides, as it is for other organic compounds. But if extremely high amounts of a compound are applied, the adsorptive and degradative capacity of the soil are exceeded, and significant leaching can occur. Unfortunately there are many such areas across the state. These areas exist where sprayers have been rinsed or where spills or leaks from bulk pesticide storage tanks have occurred. Sometimes excess spray solution has been dumped with rinse water. Standard practices of the past were not considered to be a threat to groundwater. Today we know they can be.

In the past the Iowa Department of Agriculture reported that the number one public complaint about agricultural chemical dealer-applicator plant sites was surface runoff of herbicides from mixing or storage areas which killed nearby vegetation. In an effort to correct this problem many sites installed small dikes or holding ponds to prevent any surface runoff. What this did was to force even more leaching of chemical into soil and eventually into the groundwater. If there is no well nearby, the localized plume of contamination may not cause an immediate problem. But if one of the town wells is nearby, it may show traces of agricultural chemicals. A few wells very near point sources have had contamination which exceeded 10 ppb. But in other cases if the well is a greater distance from the center of the contamination plume, or if large amounts of uncontaminated water are drawn through the plume, it is diluted and contamination levels are lower.

It is significant that no insecticides were detected in the public water survey. Only herbicides were detected. Some insecticides are low in solubility or strongly adsorbed, so it is not surprising that they were not found. But one popular insecticide - Furadan - is soluble and has occasionally been detected in groundwater in certain situations in a few other states. Furadan has not been detected in groundwater in Iowa. There is a major difference in the way popular herbicides and the most common insecticides (the rootworm insecticides) are applied. Herbicides are usually mixed with water and sprayed onto fields. Rootworm insecticides are applied as granules. There is no contamination due to rinsing sprayers when using these insecticides. There is no problem of disposing of a few gallons of spray left over in the sprayers. Left-over granules can be simply saved or are often used up on the next field planted. The point source problem which exists with herbicides does not exist for the majority of insecticides used in Iowa.

The agricultural chemical industry did recognize contamination from pesticide storage and mixing areas as a significant problem and sought regulations to control it. In 1983 the Iowa Fertilizer Chemical Association began work on proposed diking and containment rules for bulk pesticides as well as fertilizers. In 1984 IFCA requested that the Iowa Department of Agriculture adopt these rules. The Department of Agriculture did adopt these rules which became effective November 12, 1986. Impervious dikes and pads which contain any rinsate, spills or runoff water must be installed by November 12, 1988. Some pesticide manufacturers have shared in the cost of installing containment systems for dealers.

Point sources of well contamination do not occur only in town at the local pesticide dealer outlet. Most farmers mix herbicides close to the farm well. Rinsing or dumping sprayers in these areas can cause the well to be contaminated. Backsiphoning during spray tank filling can lead to contamination. Pesticides are sometimes stored near the well, which can cause contamination if containers leak.

So how does this understanding of how groundwater contamination occurs help us in protecting groundwater? We now know that point sources are a very major cause of contamination. Pesticide mixing-loading and storage areas must be protected with impervious dikes and pads. Excess spray solution should be used up on fields according to label directions. Rinsing sprayers in the field also avoids the problem of what to do with rinsate at a central site. Farmers must be told to stop mixing herbicides, rinsing sprayers and storing pesticides near wells. Mixing and rinsing in the field will eliminate much of the contamination problem.

Our efforts to reduce pesticide use through methods of being more efficient such as scouting and using Integrated Pest Management principles, band application of herbicides, rate selection and sprayer calibration have good economic and environmental basis, but should not be expected to have a major positive impact on groundwater contamination if leaching with normal use does not occur significantly for most products.

There are especially vulnerable areas which will require special practices or where certain products should not be used. Sinkholes are important. They do allow surface water contaminated with pesticides to bypass the filtering ability of the soil. Planting grass filter strips and/or building berms around them can reduce to some degree the amount of pesticides (but not necessarily nitrate) delivered to the groundwater. Similarly surface inlets of agricultural drainage wells can allow surface water to directly enter groundwater. Very sandy soils can allow leaching of certain products. Applicators need to observe the groundwater advisory statements on pesticide labels and use alternative products in those areas.

The misconceptions about groundwater contamination are correctable. The public perception and picture painted in the press has seemed to be: "Farmers use too many chemicals. Get them to use less and that will solve the problem". The real world situation is not that simple. We have to understand the processes of contamination in order to design practices that prevent it. We need to recognize that pesticides each have unique properties. They are not all alike. With better knowledge and intelligent use of that knowledge we can regulate and solve the right problem, and effectively protect groundwater quality in Iowa.

January 11, 1988

Interpretation of Pesticides in Groundwater Monitoring Data in Iowa

Prevention of pesticide contamination of groundwater requires an understanding of how pesticides may reach groundwater. Misinterpretation of groundwater monitoring studies can result in the misidentification of the mechanisms or routes of contamination. This in turn can result in the development of inappropriate or ineffective procedures to eliminate the contamination. It is our judgement that there are prevalent misconceptions about how groundwater contamination occurs in Iowa. These misconceptions threaten to hinder the development of effective practices to prevent contamination.

Certain pesticides may sometimes leach through the soil with normal use to reach shallow groundwater. The use of persistent and mobile products like Temik or DBCP has caused contamination of groundwater in other states. Recent studies in Iowa and elsewhere indicate for most pesticide products used in Iowa, if leaching with normal use occurs, it results in transient and very low level contamination (less than one part per billion). This leaching is probably the result of water movement quickly from the pesticide-treated soil surface to the saturated zone through preferential flow paths sometimes characterized as macropores and may likely occur from a major rainstorm. The transient nature of this pesticide movement is related to the short life of most pesticides used in Iowa; the one exception is atrazine which may sometimes leach to shallow groundwater in detectable quantities. Very sandy soils may also allow leaching of certain other products but only in defined areas. We believe that the persistent presence of higher levels of contamination in groundwater, particularly for pesticides other than atrazine is not due to leaching with normal use, but is due to another cause described below.

An analysis of data from the Iowa Public Water Supply Survey has confirmed the importance of another major cause of groundwater contamination in Iowa; previously unsuspected point sources. Soil normally adsorbs or holds pesticides until they degrade naturally. However, if extreme rates are applied, the adsorptive and degradative capacities of the soil are overloaded and leaching can occur. Unfortunately many areas of high herbicide concentrations occur in Iowa at locations where these products have been stored and mixed, sprayers rinsed, or where excess spray mix has been improperly disposed. Many of the public wells which have had detectable herbicide contamination are near pesticide storage or mixing and loading points. Farmers also often mix herbicides or rinse sprayers close to the farm well. Direct contamination of farm wells by backsiphoning can also occur when filling sprayers.

These point sources of contamination must be eliminated if we are to protect groundwater in Iowa. Bulk pesticide storage and mixing areas should be protected with water-tight dikes and pads. Iowa Department of Agriculture and Land Stewardship rules now require this protection. Farmers need to be directed to refrain from storing or mixing pesticides or rinsing sprayers close to wells. Our efforts to reduce pesticide use through greater efficiency and selection and through alternative pest control techniques have a good environmental and economical basis, but should not be expected to have a major measurable positive impact on groundwater quality if leaching with normal use is not the cause of contamination.

There are especially vulnerable areas in Iowa that will require the adoption of special practices. Sinkholes are an important and predominant cause of detected contamination in parts of northeast Iowa. Alternatives to surface inlets on agricultural drainage wells need to be developed. Thus efforts to protect groundwater need to be developed to meet local needs.

Analytical techniques will continue to improve in the future, thus trace concentrations of chemicals will be detectable at lower and lower levels. Even with improved pesticide chemistry and application techniques, it is likely that detectable traces of pesticides will continue to be found in certain water sources. It is our judgement that if pesticides are to be used, truly zero residues are not possible, and some system of health-based standards is necessary to indicate the safety of water supplies. Because of inherent problems which occur in detecting trace quantities of chemicals, analyses can sometimes indicate the presence of a pesticide when it is not actually present. When pesticide residues are detected in groundwater, every effort should be made to confirm the results prior to public release of data.

Dr. Richard S. Fawcett
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Richard S Fawcett

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Mr. Maslyn. Dr. Fawcett, in his paper, states:

> A great deal has been learned from the research conducted across the Nation in the last year. The evidence more and more points to a different cause of contamination than depicted by the Iowa Department of Natural Resources. For certain persistent or highly mobile pesticides, infiltration with the normal use does appear to be an important cause of detected contamination. Examples include leaching of temic in sandy soils in Wisconsin and DBCP in California. But for most of the other pesticides commonly used in Iowa, a different cause of contamination is becoming clear.

He goes on to point out the relationship, or the new information that's being generated on the role of point sources in the ground water problem, as opposed to the nonpoint source from broadcast applications on the fields. That was brought out in a number of witnesses this morning. The role that these point sources—cracked wells, mixing and loading stations too close to wells, or back siphoning—play is becoming clearer and we are finding that more and more these are a cause of a number of the problems in Iowa.

Dr. Fawcett concludes:

> The misconceptions about ground water contamination are correctable. The public perception and the picture painted in the press seems to be farmers use too many chemicals. Get them to use less and that will solve the problem. The real world situation is not that simple. We have to understand the processes of contamination in order to design practices that prevent it. We need to recognize that pesticides each have unique properties. They are not all alike. With better knowledge and intelligent use of that knowledge, we can regulate and solve the right problem and effectively protect ground water quality.

I think the thrust of his remarks has been the emphasis that we are still on a learning curve, as Suzan Wayland, Deputy Director of EPA's office of pesticides, mentioned this morning. We are continually learning more and more about the causes and effects of pesticide contamination of ground water. The whole thrust of his paper is that we need to be sure we are solving the right problem.

All of this underscores the need for increased information, education, and research. This committee has spent considerable time preparing legislation addressing the research and information component to the problem. We commend you. The Farm Bureau fully supports and encourages those efforts and has spent considerable effort in similar education and training programs among our own members. In addition, the EPA nationwide Pesticides in Groundwater Survey, which is just beginning, should yield valuable information on the extent of the problem. So we believe that while it is important to respond to this issue, Federal policy must be reasonable, careful, and in proportion to our knowledge and understanding of the problem.

One of the major areas of debate has been the definition of the resource area that we are protecting. We believe that the definition of underground sources of drinking water should recognize and distinguish between different types of ground water, different uses, and other factors such as depth, quality, and quantity. It is important to allow for flexibility in responding to contamination problems from a resource standpoint alone in establishing priorities for different types of ground water.

Another important issue in the ground water debate has been the standard of protection. We need to set standards that are reasonable and practical, but also protective of public health. We have supported the use of the Maximum Contaminant Level as the standard of protection for both public—which is current law in the Safe Drinking Water Act—and private wells. We believe that it is not only unnecessary, but could be counterproductive to establish a set of standards protecting rural ground water that are more restrictive, more stringent than those that are used for public water systems. It would result in confusion and overprotection. It could also erode public confidence in the safety of their water supply if we have two different sets of standards, one for private wells, and one for public water systems.

We do support the use of action levels as a percentage of the MCL. We need to make clear that we must avoid exceeding the MCL, that standard, and part of the FIFRA ground water provisions that have been eluded to several times today. An element in each of those bills has been the concept of a trigger, whether it be 25 percent or 30 percent of the standard, that lowered percentage at which point you take action to avoid further problems. It's a warning sign that farmers believe very strongly in and fully support.

We also believe that any Federal ground water legislation should directly involve the Department of Agriculture in a full and substantive way. There is a role for the Federal Government and a role for the State government. We believe that the State governments should have the primary role in protecting ground water. It is a site-specific and soil-specific resource. However, the Federal Government does have a very, very important role. The Federal Government's primary responsibility should be the establishment of standards, not just for a handful of pesticides, but for all of the pesticides that are believed to have the potential to leach.

Relating to the subject of pesticide contamination, the Federal Government should focus on the authority to register, review, and cancel pesticides that pose unacceptable nationwide risks. In addition, the Federal Government can play an important role in providing information and technical assistance to States and pesticide users.

I commented on the Department of Agriculture's role. This is something I believe very strongly in. I think it is deficient in most of the bills that we see currently pending before Congress. I believe that no other Agency of the Federal Government has more outreach capability, more scientific capability, and knowledge about soils and water than the Department of Agricultural and their related agencies. What they have—and what other agencies don't have—is the confidence and the outreach to the agricultural community at the local grassroots level. I've strongly believed that Federal ground water policy should include USDA in a substantive way.

I want to reiterate our support for efforts to protect ground water from pesticide contamination. No other segment of society has more at stake in this issue than the farmer who depends on wells for drinking and agricultural chemicals to protect his crop investment. Farm Bureau has made extensive efforts to train, inform, and educate our members about ground water protection.

I've included a couple of publications that we have prepared, some in cooperation with the National Allied Chemicals Association, USDA, the aerial applicators, and another one that was done by our own organization, which is an environmental audit or a checklist. We have distributed literally tens of thousands of these directly to our members, training programs and workshops. We continue to do that. We also have an ongoing well testing program that has enabled thousands of farmers across the country to test for contaminants as well as some pesticides.

We look forward to working with you and your staff constructively to address these areas of mutual concern.

Thank you.

Mr. **Oberstar**. Thank you very much, Mr. Maslyn.

That's a very thorough presentation. I particularly appreciated the numerous examples of Farm Bureau programs in various States. It's very, very helpful information. It adds to our fund of knowledge on this complex subject.

Our last panel witness is Mr. Jessen of the Freshwater Foundation.

Mr. **Jessen**. Thank you, Mr. Chairman.

My name is Marty Jessen. I'm the new president and CEO of the Freshwater Foundation, a nonprofit organization formed in Minnesota 20 years ago by some very forward thinking individuals. The Foundation is a research and public education organization committed to keeping our waters usable for human consumption, industry, and recreation.

The initial thrust of the Foundation was to build and equip the Gray Freshwater Biological Institute located in Navarre, Minnesota, that has since been given to the University of Minnesota. It is housed in the College of Biological Sciences and pursues some of the answers to the issues and problems facing freshwater in this country and in the world.

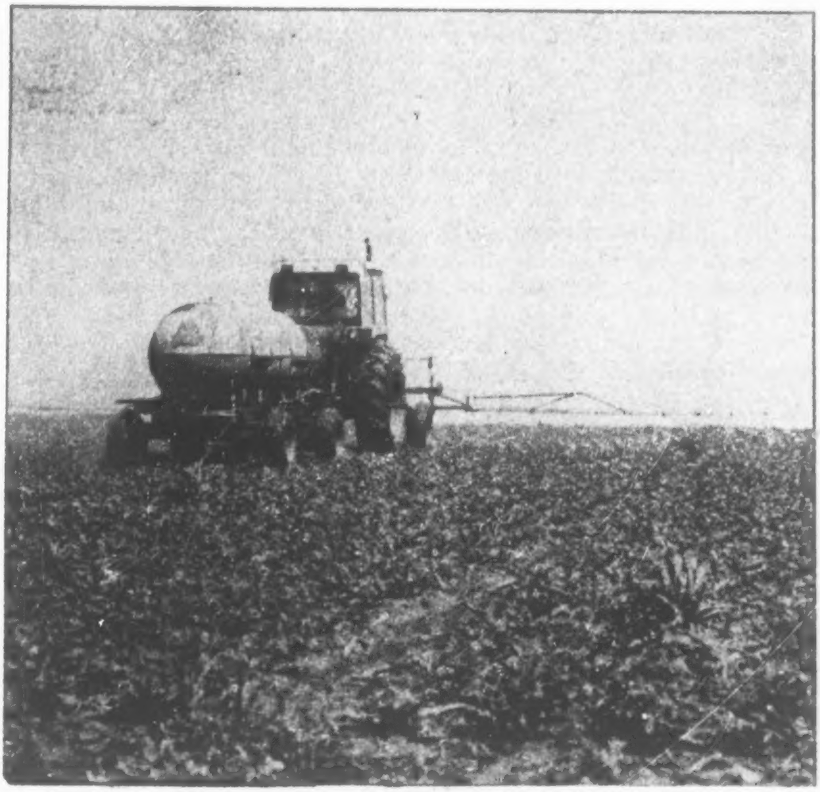
I've been asked to address the public education efforts of the Foundation with regard to ground water and agrichemicals. I would like to pay particular attention to a couple of the conferences that the Foundation has organized.

We have essentially undertaken three major efforts in ground water education. The first, in 1985, in the form of a ground water issue of the Journal of Freshwater. I have a few copies of these available for your staff if you would like for them to have it. It gives a quick overview in a laymen's terms of the issues and interrelationships of ground water and the effects that man has had and is having.

Mr. **Oberstar**. Thank you very much. We'd appreciate having that.

[The following was received from Mr. Jessen:]

Pesticides and Groundwater: A Health Concern For The Midwest



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The Health and Environment Network is a national information exchange among medical and other health professionals on new programs, reports, research and issues of an environmental health nature. The Network provides information through a monthly newsletter, conferences and related publications. For more information on the Network, contact the Freshwater Foundation.

Freshwater Foundation, 2500 Shadywood Road, Box 90, Navarre, Minnesota 55392
Cover photograph by Thomas Hovland/Grant Heilman Photography

Pesticides And Groundwater: A Health Concern In The Midwest

Pesticides are vital to Midwestern agriculture and traditional methods of crop production. Agricultural pesticides account for 79 percent of all pesticides used in the United States today, and are being used at a rate nearly triple the amount used in 1964.

Of growing concern in the Midwest is evidence that pesticides are entering groundwater, posing a potential threat to drinking water for people and livestock.

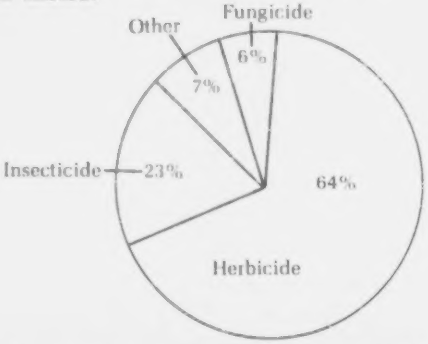
The use of pesticides is a complex issue, involving both risks and benefits. The public health risks associated with the presence of pesticides in water supplies must be carefully weighed against the economic benefits gained by using them on crops. In making choices about the use of pesticides, we need to know how they work, how they might find their way into groundwater and what the possible health effects might be.

What Are Pesticides? Why Are They Used?

Pesticides are used to repel, control or destroy undesirable plants or animals. Each type of pesticide is designed to work in a specific way on specific pests. Herbicides (weed control pesticides) account for the majority of agricultural pesticides used in the Midwest, followed by insecticides (insect control pesticides) and fungicides (disease control pesticides). Other pesticides are used to a limited extent to control such pests as rodents, algae and mites.

Uses of Agricultural Pesticides

(1984, EPA estimate)



Pesticides are used in modern crop management because of their effectiveness in controlling pests that reduce crop yields. Pesticides also can aid conservation tillage methods that greatly reduce soil erosion and can reduce the fuel costs associated with plowing and discing.

How Much Do We Depend On Pesticides In The Midwest?

According to the U.S. Environmental Protection Agency (EPA), about 1.08 billion pounds of pesticides were used in the United States in 1984. In the Midwest, where 70 percent of the nation's corn and soybeans are grown, three-fourths of the row crop acreage is devoted to these two crops. Because weeds are the most prevalent pest problem in growing corn and soybeans, herbicides are normally applied to more than 90 percent of these crops at an average rate of 2.0 pounds per acre. Although insecticides and fungicides are used less widely on these crops to control insect and disease problems, their use is still significant. Approximately 50 percent of all corn acreage is treated with an insecticide at planting, and most corn seed is coated with a fungicide.

Pesticides are applied to other crops as well. About 50 percent of the acreage planted in wheat, barley and oats is treated with herbicides. Some crops, such as vegetables, potatoes, sunflowers and sugarbeets often receive multiple pesticide applications.

Common Pesticide Usage In The Corn Belt

		CORN	SOYBEANS
		% Of Acreage Receiving Pesticide	
Herbicide	Atrazine	57	-
	Alachlor	43	36
	Cyanazine	24	-
	Metolachlor	22	-
	Butylate	20	-
	2,4-D	13	-
	Dicamba	12	-
	Metribuzin	-	50
	Trifluralin	-	45
	Metolachlor	-	14
	Linuron	-	13
	Bentazon	-	20
	Chloramben	-	13
Insecticide	Chlorpyrifos	14	-
	Fonofos	12	-
	Terbufos	12	-
	Carbofuran	6	-
	Phorate	3	-
	Other	7	

*Percentages total over 100 because some acreage may receive more than 1 chemical.

Minnesota Department of Agriculture 1985

Why Should I Be Concerned About Pesticides In Groundwater?

Groundwater is the source of drinking water for 97 percent of rural Americans and is the primary source of irrigation water in the Midwest. According to a 1986 EPA report, 17 pesticides, some of which can cause cancer and other harmful health effects, have been found in groundwater in 23 states. As more states conduct groundwater sampling programs for pesticides, these numbers are expected to increase. In the Midwest, the states of Wisconsin, Minnesota, Nebraska, North Dakota and Iowa have found detectable levels of some pesticides in groundwater.

Once groundwater has been contaminated, it is difficult to completely remove the contamination. If the water is unsuitable for human use, it may also be unsuitable for agricultural uses, and alternative sources of water must be found.

How Can Pesticides Get Into Groundwater?

Pesticides can gain direct access to groundwater by activities such as spills around a poorly sealed well, back-siphonage during spray tank filling or improper disposal of pesticide containers. Another, though less direct, contamination route is pesticide movement down through the soil into groundwater. This can happen in areas of concentrated pesticide usage such as mixing areas or disposal areas or spills on the ground. Recently, there has been concern about movement of pesticides through the soil into groundwater when pesticides are applied to fields under normal farming practices.

Chemical and soil characteristics are factors that influence groundwater contamination under normal crop application. Both can vary greatly.

Chemical Characteristics

Chemical characteristics of importance are water solubility, adsorption and persistence. The **solubility** (ability of a chemcial to dissolve in water) of pesticides varies greatly, ranging from virtually insoluble to very soluble. Generally, the greater the water solubility, the more potential there is to leach, or "seep down" into the water table. Small differences in solubility can significantly affect the leaching potential of a pesticide. This can be particularly important if the pesticide is highly toxic.

Adsorption (the physical/chemical interaction, or bonding, of pesticides with the soil) prevents or retards leaching into groundwater by holding the pesticide in the active surface soil where most of the breakdown activity occurs.

Persistence is the ability of the pesticide to resist degradation or "breakdown" as it moves through the soil. It is measured in half-life (the amount of time for half of an amount of chemical to degrade).

Pesticides can be broken down in the soil to simpler compounds. The degree of breakdown varies with the pesticide. For most pesticides, the breakdown products are less harmful than the parent compound; however, certain pesticides produce breakdown products which are potentially more hazardous.

Persistence

Persistence of pesticide with 2 week half-life assuming constant conditions.

TIME	%REMAINING
Application	100
2 weeks	50
4 weeks	25
6 weeks	13
8 weeks	6
10 weeks	3
12 weeks	1

Soil Characteristics

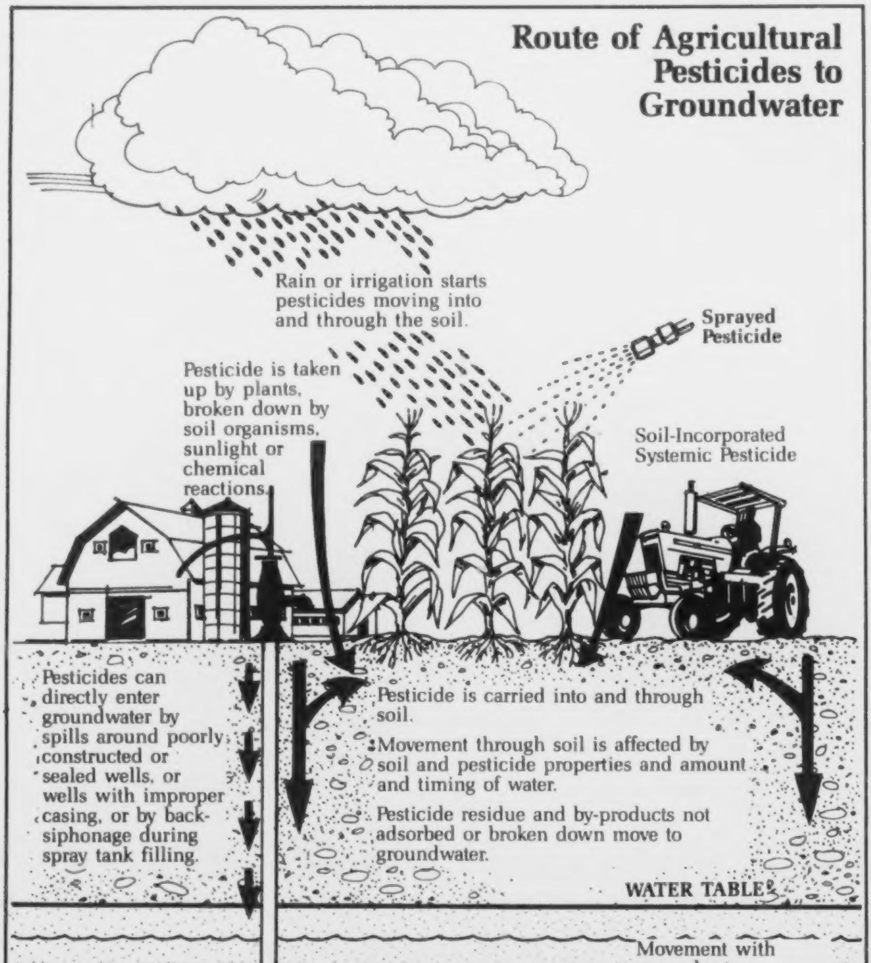
Pesticide breakdown occurs primarily in soil by sunlight, soil organisms or reactions with minerals or natural chemicals. Soil properties influence the time a pesticide will be held in the soil. Organic matter content and texture are the two most important characteristics of the soil.

Organic matter is material derived from the decomposition of formerly living plant and animal matter. As organic matter increases, so does adsorption ability, water holding capacity and breakdown activity by chemicals and organisms.

Texture of the soil is determined by the sizes of mineral components such as sand, silt or clay. Coarse textured (sandy) soils allow rapid water infiltration, limit the soil/pesticide contact and, as a result, enhance potential for pesticide movement to groundwater. By comparison, fine soils (those made up of silt and clay) slow water infiltration, increase soil/pesticide contact and, as a result, limit potential for pesticide movement to groundwater.

The amount and timing of water applied to the soil — either through precipitation, irrigation or both — is also a factor in pesticide leaching to groundwater. This factor is especially important in sandy soils where irrigation or heavy precipitation may enhance pesticide leaching through the soil.

Certain geologic conditions can result in greater susceptibility to pesticide contamination of groundwater. Karst topography, a condition of fractured limestone bedrock and sinkholes, limits the soil/pesticide contact and can result in rapid surface-to-subsurface movement of water, which creates a greater potential for contamination.



Route of Agricultural Pesticides to Groundwater

Rain or irrigation starts pesticides moving into and through the soil.

Pesticide is taken up by plants, broken down by soil organisms, sunlight or chemical reactions.

Pesticides can directly enter groundwater by spills around poorly constructed or sealed wells, or wells with improper casing, or by back-siphonage during spray tank filling.

Pesticide is carried into and through soil.

Movement through soil is affected by soil and pesticide properties and amount and timing of water.

Pesticide residue and by-products not adsorbed or broken down move to groundwater.

Movement with groundwater — additional breakdown generally slowed, but depends on chemical nature and groundwater.

Adaptation from University of Wisconsin — Extension, Cooperative Extension Service

Why Can Pesticides Be A Health Problem?

Although pesticides are targeted at specific organisms such as weeds or insects, they may also, under certain circumstances, be hazardous to people. The public health hazard depends on the degree of toxicity (the ability to produce an adverse effect) of the pesticide, the frequency and length of time a person is exposed to the pesticide and the means of entry into the body.

There are two basic types of toxicity to people — acute and chronic. **Acute** health effects generally refer to toxic effects apparent after only a short period of exposure measured in minutes, hours or days. These effects are usually the result of a relatively large single exposure. **Chronic** health effects occur after prolonged or repeated exposures to low doses of toxic substances. In this case exposure may continue for weeks, months or years before disease is apparent.

Pesticides can enter the body in three ways: inhalation, ingestion and skin or eye absorption. **Inhalation** often produces the greatest toxic effect. Inhalation risks can occur from handling pesticides, spray movement during application and smoke from burning pesticide containers.

Most incidents of acute poisoning occur through **ingestion.** Acute exposure from ingestion can result when pesticides are stored in inappropriate containers and are mistakenly used in food preparation. Chronic exposure from ingestion may occur from residues remaining on food or from long-term consumption of drinking water contaminated with low levels of pesticides.

Pesticides can also enter the body by **absorption** through the skin and eyes. For pesticide applicators, this is one of the most common ways of accidental poisoning.

What Are The Health Implications Of Pesticides In Water Supplies?

If pesticides enter a water supply in large quantities, as can happen with spills or back-siphonage accidents, acute health effects can range from moderate to severe, depending on the toxicity of the pesticide and the amount of exposure.

However, pesticides found in groundwater from indirect sources of contamination occur in very small quantities generally ranging from 0.1 to 10 parts per billion (ppb). Contaminated groundwater used for drinking water supplies may result in chronic exposure, which may be hazardous to people and livestock.

The health implications of long-term consumption of water contaminated with very low levels of pesticides are not clear. With some pesticides, toxic effects occur only when a certain level of the chemical in the water is reached. For example, a particular pesticide's primary effect may be on the nervous system, but health effects are not expressed until a certain amount of the pesticide is ingested from the water. At that level, people consuming the water are at risk for chronic effects on the nervous system.

On the other hand, if a particular pesticide is potentially carcinogenic (able to cause cancer), there is no concentration at which this pesticide can be in a water supply without some small risk of cancer to the consumer. Scientists believe that carcinogens can induce cancer even at very low levels of exposure. For example, a carcinogen at an exposure level of several parts per billion might produce one cancer in a population of 100,000 if that population was exposed to the carcinogen over their lifetime. A few of the pesticides most commonly used in the Midwest are suspected of being potentially carcinogenic.

Individual health risk from exposure to pesticides depends in part on the health status of the individual. Persons with existing health problems, infants and the elderly may be at greatest risk.

In some cases when several pesticides have contaminated a water supply, they can produce health effects in combination that are greater than the sum of their individual toxic effects. Very little is known about this phenomenon called **synergism.**

First Aid For Acute Pesticide Poisoning

Poisoning symptoms may appear almost immediately after exposure or may be delayed for several hours, depending on the chemical dose, length and mode of exposure, and the individual. These symptoms may include, but are not restricted to:

- headache
- giddiness
- nervousness
- blurred vision
- cramps
- diarrhea
- general numbness
- abnormal pupil size

In some instances: excessive sweating, tearing or mouth secretions.

Severe cases may be followed by:

- nausea and vomiting
- changes in the heart rate
- breathing difficulty
- coma
- fluid in the lungs
- muscle weakness
- convulsions
- death

Pesticide poisoning may, however, mimic brain hemorrhage, heat stroke, heat exhaustion, low blood sugar, pneumonia, asthma, or other severe respiratory infections.

Regardless of how trivial the exposure may seem, if poisoning is present or suspected, obtain medical advice at once. If a physician is not immediately available by phone or the nearest poison control center cannot be contacted, proceed directly to an emergency ward. Take along the pesticide label. First-aid treatment is extremely important regardless of the time that may elapse before medical treatment is available.

How Much Is Known About The Health Risks Of Pesticides?

The greatest problem in defining the risks from chronic exposure to pesticides is the lack of comprehensive chronic health effects information on many pesticides — information such as the type of health effects and the level at which they might occur.

There are a number of reasons for this lack of information, or data. For the most part, studies of human populations exposed to chronic low levels of pesticides have produced very little information on what health effects might be expected. As a result, most health effects information comes from research using laboratory animals. It is very difficult to translate the results from laboratory animal research to humans. Laboratory research also involves considerable cost and time. Nevertheless, the data base of information on chronic health effects and the associated levels of exposure is growing and has improved markedly over the past several years.

How Are Pesticides Regulated?

Pesticide use and commerce is regulated by the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and by state law and regulation. Each pesticide must undergo a registration process conducted by the EPA before it is marketed for use to ensure that it does not cause unacceptable human health effects.

Many of the pesticides on the market today were first registered for use in the 1950s and 1960s before present levels of health testing were required or before pesticides were thought to leach into groundwater. FIFRA requires the reregistration of these "old" pesticides to ensure they meet new registration standards. This process is currently under way by the EPA and will produce health effects data on these pesticides. If new data show potential adverse health effects, the EPA could revoke the pesticide's registration.

Are There Health Standards For Pesticides In Drinking Water?

Although the registration process does generate health effects data, there are very few health standards for pesticides in drinking water. Developing regulations is a very complex and time-consuming process that involves balancing the economic need for using the pesticide against the potential harm that may be caused by its use. To date, the EPA has set drinking water standards for only 6 pesticides. Except for 2,4-D, most of the commonly used pesticides in the Midwest do not have drinking water standards.

In the next couple of years, the EPA will continue to develop public drinking water regulations for many more pesticides. In the meantime, several state health departments in the Midwest have developed drinking water advisories for many of the pesticides used in the Midwest. These advisories do not carry the weight of regulations, but they do serve the purpose of determining whether or not a contaminated water supply is safe to drink.

Because all pesticides are to some degree inherently toxic to humans, it is impossible to completely eliminate risk through regulation without banning their use entirely. This is particularly true for pesticides that are toxic at very low levels of exposure and for pesticides that are suspected carcinogens. **Consequently, to gain the benefits of pesticide use there must be a willingness to tolerate some degree of risk.**

How Can I Find Out If Pesticides Are In My Drinking Water Supply?

Pesticide levels are not part of routine private well water testing, and most state health departments do not provide the service of testing wells for pesticides. Because the levels found in groundwater are so low, only highly technical laboratories can conduct pesticide testing. Such testing can be expensive, ranging from less than $100 to more than $1,000, depending on the number of pesticides tested for.

Interested persons can contact their state health departments for a list of qualified testing laboratories, or (if they feel their well has been contaminated) for advice on the safety of using the water supply.

Treatment of groundwater with filters or distillation units on domestic taps can be expensive and is not always successful. **The best policy is to keep pesticides out of groundwater in the first place.**

What Can We Do To Protect Our Groundwater Supplies?

There are ways that groundwater can be protected while still using pesticides. A number of these methods involve simple common sense. Some of them involve using alternative application techniques or pest control.

- When storing, mixing or loading pesticides or when rinsing containers, conduct these activities as far from wells as possible.
- Minimize back-siphonage possibilities by installing back flow prevention devices and keeping hose ends out of chemical tanks.
- If pesticide spills or accidents occur, notify responsible local or state personnel immediately. In most Midwestern states, the appropriate agency is the State Department of Agriculture.
- Read and follow label instructions. Labels provide legal as well as product information.
- Triple-rinse containers immediately after emptying, and crush or puncture top and bottom of containers to prevent reuse.
- After triple-rinsing, consult label for disposal instructions. Avoid burying unless in a permitted sanitary landfill.
- Return rinse water to spray tanks and apply rinse water to crops according to application instructions, or use rinse water to mix new spray solutions of the same pesticide.
- Maintain and calibrate pesticide application equipment to apply the product properly.
- Consider solubility, adsorption and persistence factors in pesticide selection.
- Scout and monitor weed, insect and disease problems. Apply pesticides only when the benefit of using it exceeds the cost.

- Test soil for organic matter and texture to assure correct application rate.
- If feasible, apply herbicides in a band along the crop row. This can be economically as well as environmentally beneficial.
- To avoid runoff in karst regions, insecticides applied at planting should be incorporated or furrow applied if label permits.

Groundwater is one of the Midwest's most important natural resources. We can ensure a source of high quality groundwater in the future only if we manage the resource wisely now. Pesticides will continue to be a beneficial part of agricultural production as increases in world population dictate the need for increased food and fiber.

But, beneficial as they are, pesticides must be used in a proper and educated manner. We must recognize that the benefits of pesticides will not be gained without some public health risk. The best way to minimize health risk and protect groundwater quality is to understand how the use of pesticides can affect groundwater resources and to integrate careful application methods with other pest control measures. Protection of human health will depend on how wisely we use pesticides in the future.

Where Can I Go For Further Information Or Assistance?

State or County Health Department
State Department of Agriculture
State Pollution or Environmental Control Agency
County Extension Office

Written by:
Larry Gust and
Tom Klaseus
Minnesota Department of Health
Gregory Buzicky
Minnesota Department of Agriculture
Paula Ripley
Freshwater Foundation

Assistance provided by:
Minnesota Pollution Control Agency
U.S. Geological Survey, Minnesota Water Resources Division

For additional copies of this brochure or other related publications, contact the Freshwater Foundation. For information on membership in the Freshwater Society, call or write:

Freshwater Foundation
2500 Shadywood Road, Box 90
Navarre, Minnesota 55392
(612) 471-8407

Mr. **Jessen**. Second, in 1986, the Foundation organized one of the very first conferences on ground water, "Pesticides and Groundwater: A Health Concern for the Midwest." The conference was organized to discuss and address a variety of issues including: factors influencing pesticide leaching; ground water monitoring of water supplies; clinical implications and research on chronic health effects; effective health standards setting; pesticide regulation; innovative approaches to protection of ground water resources; and other topics.

While focused toward the midwest, participants came from 26 States throughout the country including California, Texas, New Jersey, Florida, and North Carolina to name but a few. I believe that that shows the interest in public education and the need to do more to provide the kinds of information that the earlier speakers on this panel have discussed. I have as well a copy of the proceedings of that conference which I would be happy to leave for you and the staff to have.

In 1987, a second conference was organized called "Agricultural Chemicals and Groundwater Protection: Emerging Management and Policy." This conference had as its purpose to explore effective management strategies and realistic regulatory policies and to solicit responses from participants as to the effectiveness of those strategies and policies. The result was the conference participants made recommendations regarding future directions for effective management and policy regarding agrichemical use. In 1987, 35 States and Washington, D.C., were represented at this conference.

The outcome of that conference is a series of 10 recommendations that focus on 3 major areas: the need for information from credible information sources; the need for funding and incentives to facilitate planning, development, and dissemination of new information for changed management; and lastly, examples of management case studies that have been proven effective. In other words, those that are working and can be modified and transferred to other locations.

That series of recommendations is enclosed in this book which is on the table over there. It is available for others who wish to have it. It is really the essence of our presentation here today. Again, I have brought along additional copies of the full proceedings, should they be desired.

In following up on those recommendations, the need for more information in those three areas, the Foundation is organizing a third national conference for October 24 and 25 on "Agricultural Chemicals and Groundwater Protection: Resources and Strategies for State and Local Management." It is tying directly into the third recommendation of that conference of last year.

This conference will highlight and analyze usable, practicable resources and implementable model programs presently in place and available to assist in more effectively balancing agrichemical use and ground water protection. The conference will focus on information resources, funding, incentive programs, and management initiatives. We expect that the attendance of this conference will exceed that of last year and will be a stepping stone to the creation of a series of regional seminars that will be available for use around the country.

Over those three years we've had a variety of cosponsors, including the conference of last year cosponsored by the EPA, National Agricultural Chemicals Association, the University of Minnesota, Minnesota Department of Agriculture, Soil Conservation Service, Extension Service, and others. We take great pride in having convened that kind of gathering and getting that variety of interests to work together to do something that we think has tremendous importance and applicability. For this fall's conference, we already have commitments from the USGS, Soil Conservation Service, and Extension for continuing support. We are getting very positive responses from others who are cooperating in that.

As has been said by several of the people who have testified here today, we've done a lot of studying. We've done a lot of analysis. Much more needs to be done, but we need to disseminate the information that we have at hand so that we can improve as we go. If we wait for the final answer, we will never do anything.

We're currently undertaking one other major program with regard to ground water contamination. It is a study of the economic impact of ground water contamination on 20 Minnesota businesses and communities. It will quantify the costs of remediation of study, litigation, decreased property values, decreased property tax revenue for municipalities, and other factors. It would be a very difficult thing to do, but I would certainly be interested in a similar study applied to agricultural practices and the effect of agricultural practices over time.

In summary, it's our view that people, agency professionals, corporations, and others all need information to make good decisions. Agricultural chemicals and ground water is, in our view, an economic, social, and political issue which manifests itself in environmental characteristics, contamination of water resources, public health problems, and so on.

Neither policy nor data replaces judgment. But in our view, there is a great need for better dissemination and translation of credible data, information, and education, if you will. I believe that for the most part people want to, and will make good decisions if they have the facts. The kinds of things that Mr. Morse said earlier indicate the kinds of positions that people are prepared to take if they know what the ramifications and tradeoffs might be.

The challenge to all of us is to get to people the best possible information in a timely fashion, in a neutral place—nonthreatening perhaps—and in a location and format convenient to them so that they can take it, understand it, and use it. It's that philosophy that shapes our efforts and is the basis upon which we have put together those two conferences and are proceeding with future planning. We think that they are models, examples that can be of great value. We would be happy to participate in any way that we can to assist in your efforts.

Thank you.

Mr. **Oberstar**. Thank you very much, Mr. Jessen.

We greatly appreciate the contribution of the Freshwater Institute which has been a leader in so many areas ever since its founding, which I have followed very, very closely over nearly two decades of operation.

Dr. Early, a number of agrichemical companies are working with companies in the biological area and developing plant genetics working in two ways.

Mr. **Early**. Yes.

Mr. **Oberstar**. One is to develop biological resistance to various plant diseases and pests in order to reduce dependance on applied chemicals. In other ways, to develop strains of plants that are resistant to ever stronger chemicals. Could you elaborate on those two directions?

Mr. **Early**. I'll be glad to, Mr. Chairman.

Not only are these companies working with other people, but they are themselves doing work in the bio-tech area. Companies like Monsanto, DuPont, and these people who are in the Ag-Chem business and also in the bio-tech business.

You alluded to one that I'm certainly aware of. We are genetically engineering plants to be more resistant to chemicals, where you could use certain kinds of chemicals without impacting other parts of the environment.

I think when we look at the role that biotechnology is going to play in this area of pesticides, there's no question it's going to play a big role. The question is: how long will it be before we're going to see the impact of this technology? Some have said, well, in the 1990's. Others have said maybe the turn of the century, 2,000. I don't think anyone really knows, frankly. What we're beginning to see though is more and more products generated that are outside the chemical area. For example, one of our members, Abbott, is doing a lot of research in the area of generating phenomones or attracters, these sort of things that are going on in the area of insecticides. I think we're going to see much more of that sort of thing coming down the road.

But in the meantime—and I think most of agriculture believes this—as we go through some of these changes that are going to happen out there, we're going to need some of these stable products to get us through this situation.

We talked about the need for agricultural chemicals. We've heard some of the comments here. You heard Mr. Maslyn talk about integrated pest management. I should have said this earlier on. Our industry, back in 1972, was an advocate of integrated pest management. We're not trying to get the farmer to use chemicals just to use chemicals. We're advocating that he use the best methods of controlling insects and weeds that are economically and environmentally acceptable to him. He should do that. If that means no chemicals, he shouldn't use them. But if he has to use chemicals to control a pest or a weed to do it in the right way, he should do that also.

Biotechnology is coming. I just don't think it's right around the corner quite yet though.

Mr. **Oberstar**. That's important to know. That was a point of my question, to ascertain, if possible, the state-of-the-art, the direction in which it's moving, and what results are hoped for in that area.

What research does the chemical industry itself do—I know you're required to do a good deal of this in certifying chemicals for sale and marketing—on health effects in various levels of concentration?

Mr. **Early**. Well, it's interesting that when you go, look, and see the history of requirements of EPA to register a product that was developed over the years, how the number of evaluations and studies have grown to the point where I said earlier, no chemicals are around that are more extensively studied than pesticides today, with the possible exception of drugs.

Back 20 years ago, you could calculate—in terms of the cost of research and development in health studies to put a product in the marketplace—maybe $2 million or $3 million. To put a new pesticide on the market today—and this relates to the health, safety, environmental studies, and all the requirements—a member of ours is looking perhaps in the neighborhood of $40 million, $50 million, or maybe $60 million. Now we're not complaining about spending the money, but what we're saying is that the number of studies being required today greatly exceeds what was required 20 years ago. We think it's appropriate to ask those questions, of course.

From a timing standpoint, from the discovery of a chemical that will have some biological activity, we're thinking in terms of eight years from that point until you get certified or a label cleared by EPA to sell the product. So it's very extensive, short/long-term studies, carcinogens, teratogens, all the various genicity studies one must go through is required by EPA. As you also heard today, they're also going through the process of updating the older chemicals that were registered appropriate at that time, 20 years ago. As the studies have increased, now EPA says you've got to bring those up to present technology. That is happening too, through the special review process.

Mr. **Oberstar**. Thank you. That's very helpful insight.

Mr. Hind, many of the environmental groups whom you've heard speak today have expressed concerns about EPA's use of the technical term "negligible risk" in ground water and other areas. What are those concerns? How do you express them? What do you propose EPA should do about the use and the way that it is used of "negligible risk"?

Mr. **Hind**. Our main problem with it, of course, is how the Agency reaches that. Right now, there is not a lot of statutory requirement about that. But Diane Baxter, a toxicologist from the National Coalition Against the Misuse of Pesticides came today to address that specific area. So let me turn the mike over to her.

Ms. **Baxter**. Good afternoon, Mr. Chairman.

I would remind you that I haven't yet been sworn in.

[Witness sworn.]

Mr. **Oberstar**. Ms. Baxter.

Ms. **Baxter**. I appreciate very much, Mr. Chairman, and members of the committee, the opportunity to be here today to answer that question. It's a very important one. NCAMP believes there is great need to consider carefully whether the institution of health-based standards ought not be the essential core rather than just some kind of negotiable issue in all environmental or public health legislation.

We think these are key to public health protection in every area. Indeed, no ground water legislation should be supported that lacks, at least, the elements of your bill, H.R. 3174. We believe that any pesticide legislation that fails to address ground water can only be thought of as a "stop-gap" measure. We believe that any ground water legislation that codifies unprotective standards is unprotective of public health from the outset.

I can quickly summarize my prepared statement, which has been submitted for the record, into three areas. I'm just going to quickly run through those. First, we have problems defining risk. Second, we have problems defining exposure. Third, we have problems determining benefits of use of pesticides. I'm going to quickly run through those one at a time.

Mr. Chairman, in spite of what you hear, we still don't do a very good job of calculating the risk to human health of use of pesticides. In fact, we consistently underestimate them because it's easier to. First, the process depends heavily on the collection and the analysis of a vast amount of data, data which we still, in many cases, do not have in our possession. The level of compliance with statutory requirements is still just too low.

I would also, as an aside, mention that many of the studies that are done with pesticides end up being proprietary work. They're not usually available for open, scientific review. They usually come from chemical companies. They are submitted to EPA for EPA's review. It's a very lengthy process to get that information out. It certainly doesn't come out before the fact of a pesticide being registered.

Another problem defining risk has to do with the scope of the data that we collect. My organization and many environmentalists agree that the scope of that data is still too limited. Just to give one example, Congress has formally recognized that we need to do a better job of assessing the neurotoxicity of pesticides. Congress believes we need to institute a drastic overhaul of that process. But we still don't have those data requirements in place. Almost all insecticides are nervous systems poisons. A lot of solvents are. Many herbicides may be nervous system toxins.

Third, we try very hard when assessing risk to focus on things like normal agricultural use. When we do that, we're repudiating reality to a degree, the reality that chemicals do get misused. Yes, there are abandoned wells out there. Point source pollution is always going to be a problem when people are mixing and loading concentrates of pesticides, making them into dilutions, and using them in the field.

My second problem with the negligible risk concept concerns exposure. I believe that that concept adds up to an unacceptable risk when all pesticide exposures are considered altogether. Even more so when exposure to other nonpesticide chemical contaminants, often found in ground water, are factored into the equation. Under a "negligible risk" standard, we are pretending that a population is exposed to one active ingredient at a time. We are ignoring the possible contribution of inert ingredients. We're ignoring the likelihood that other chemicals are part of the total exposure picture at any given time. EPA identified for Congressman Waxman, I believe, (and the National Academy of Science report that has been quoted here today centered on the same list), some 55 agricultural chemicals in current use on food crops today that are carcinogens. Many foods may have residues of different pesticides on them at any given time. So, with water, are we likely to find residues of multiple chemicals in any given sample?

My third problem with the "negligible risk" concept concern the problem of determining the benefits of use. If, as a society, we are prepared to accept all sorts of poorly defined risks, then the regulators have to be prepared to rigorously define the supposed benefits of pesticide use. They should be prepared to look, in particular, at the benefits of all nonchemical alternatives available, and show why the assumption of increased risks should be considered beneficial to society. We shouldn't do it later. We should do it first.

It is very rare that there has ever been any commitment among regulators to explore what alternatives to the use of pesticides exist before registering products, before the products are used. Nor has there been a concerted effort among them to consider alternatives. We believe that this is quite obvious when you consider that efficacy data is hardly ever required on pesticides. One example that came to my attention recently is a comparison of corn root worm insecticides. Their efficacy seems to have nothing to do with how toxic they are to the root worm, but rather (has to do with) the ability of some of these things to move into water and get into the rather large root system of the corn plant where the corn root worms are.

In summary, "negligible risk" standards don't do anything to encourage the adoption of least toxic food production practices that will be protective of the environment

Again, I appreciate being able to participate in your hearing today.

Mr. OBERSTAR. Thank you.

Let me ask Dr. Early. I know that the industry has done a number of analyses. You have to market chemicals on the basis that they will provide a return to the farmer for his investment in those chemicals in protecting them against pests and against competing weeds and so forth. What cost benefit information do you have that you could share now, or supply for the record on that aspect?

Mr. EARLY. I'd be glad to supply something for the record, Mr. Chairman. I should point out that an interesting thing has happened. I think in an appropriate way over the last 10 years is that 10 years or 20 years ago the Environmental Protection Agency was requiring a great deal of efficacy data. Data as to whether or not a product would really kill insect A or weed B, and so forth, like that.

Because of the constraints on resources, personnel, and so forth, the Agency made the right decision that says, let us focus more on health and safety issues as opposed to efficacy issues. That wasn't quite "let the farmer beware." I know that Mr. Maslyn wouldn't want me to say that. I thought it was appropriate that they moved toward the health and safety area.

But I think what happens in the real marketplace out there, the farmer is very sophisticated. He's not a dummy out there. He's going to buy a product that does that job for him. If he doesn't get a $3 return for every $1 he spends, I don't think he's going to buy the product, frankly. I think he's making an investment. Some of these are significant investments when he's putting it out there.

The point I'm making here is, there is a lot of efficacy data available. The companies have to be satisfied themselves before they put a product on the marketplace if they're going to stay in the marketplace. Otherwise, they'll not make this long-term investment on health and safety issues.

So EPA has not looked as closely at efficacy data in the last few years, focusing more on health and safety. The farmer is looking at that efficacy area. The manufacturer is certainly looking at efficacy.

Mr. OBERSTAR. You will be able to supply some information on yield benefits and so on?

Mr. EARLY. Yes, we can. We'd be glad to.

[Mr. Early provided the following which have been retained in subcommittee file: Material copied from the "CRC Handbook of Pest Management in Agriculture"; one deals with insecticides, another deals with herbicides; and the third deals with fungicides. Two from USDA that deal with field corn and soybeans. A paper presented by Dr. Burnside of the University of Nebraska dealing with benefits of herbicides and the comparison of chemical and nonchemical weed control methods.]

Mr. OBERSTAR. Yes. I know you have other questions or responses you would like to make, but I would like, at this time, to yield to the gentleman from Pennsylvania.

Mr. CLINGER. Thank you, Mr. Chairman.

I want to join you in thanking the panel for very interesting testimony, some universal, and some in disagreement on this issue.

But I would like to direct one question to the entire panel which is: of the groups you represent, were any of the groups consulted or involved in the development of EPA's ground water protection strategy? And whether you were or were not consulted, what is your opinion of that strategy? We'll just start with Mr. Jessen, and go right down the line.

Mr. JESSEN. We were not directly involved in any real ongoing basis. I think that there's a great difference of opinion about the strategy and the various approaches to ground water protection. While we're fighting over the differences, we'll probably not make very much progress. We need to find a way to get people to find whatever common ground we can and move forward.

Mr. CLINGER. Senator Morse.

Senator MORSE. I don't feel qualified to respond for the Farmers Union in that regard. I'm not familiar enough with their involvement, so I think I'll just pass.

Mr. CLINGER. OK.

Mr. Maslyn.

Mr. MASLYN. Congressman, we were involved in both of the workshops that Ms. Wayland spoke of this morning. We generally support the strategy. It recognizes, fundamentally, the role of the States. The States should play a role in this ground water area. I noted that Ms. DuBois—or I discerned from her comments—that she had some trouble, that New York State was almost given too much of a burden to deal with.

I think the ground water area is a tremendously complex area. But that does not refute the need for strong State involvement. This issue is a local issue by its very nature. It's a site-specific and soil-specific issue. The States and local governments, by their proximity to the problem, and should have a strong primary role in this.

If the question is technology or funding, or information, that can be resolved. I think that's an appropriate role of the Federal Government. The strategy also recognizes that.

Mr. CLINGER. Dr. Early.

Mr. EARLY. Mr. Clinger, we in our industry were delighted to see the EPA respond with this strategy. We've been encouraging them to do this all along because of the unknowns associated with it. What they've done is most appropriate. We've been generally supportive.

What I would like to do, with your permission—this is our response of their strategy, which is overall supportive. There are a couple of little knicks and knacks there that we think ought to be corrected. But I think they are moving in a very responsible way. I would agree with what Mr. Maslyn says.

Mr. CLINGER. Will you submit your response for the record?

Mr. EARLY. I'd like to.

Mr. OBERSTAR. We will have the staff review the document.

Mr. EARLY. Thank you, Mr. Clinger.

[Letter dated June 24, 1988, to EPA in re: Agricultural Chemicals in Ground Water: Proposed Pesticide Strategy follows:]

naca

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June 24, 1988

Information Services Section
Program Management and Support Division
TS-757C
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

RE: Agricultural Chemicals in Ground Water: Proposed Pesticide Strategy

Dear Sir/Madam:

The National Agricultural Chemicals Association (NACA) is pleased to have this opportunity to present its views and comments on the EPA Agricultural Chemicals in Ground Water: Proposed Pesticide Strategy, 53 FR 5830, February 26, 1988. The protection of ground water and the continued safe and beneficial use of our industry's products is a major commitment of NACA.

NACA supports ground water regulation of pesticides which is designed to: 1) protect public health and the environment; 2) mitigate or prevent pesticide movement into ground water; and 3) maintain our high level of agricultural productivity. In general, we believe the strategy as written provides for these conditions to be satisfied provided certain pivotal issues are properly addressed in substance and implementation. NACA recognizes that EPA, itself, also has questions on certain key issues and seeks answers to them through this public comment process.

The two major issues that NACA believes the proposed strategy raises are: 1) how to maintain an effective national uniform system for the regulation of pesticides, and 2) the definition and implementation of scientifically-based criteria for managing pesticide risks to ground water that preclude arbitrary and inequitable removal of pesticides as viable economic tools in agricultural production. Although addressed in greater detail in the attached comments, NACA would like to emphasize that acceptable resolutions to these issues are only possible by embracing sound scientific principles and clearly defined institutional arrangements between federal and state levels of governments. A federal and state partnership must be one that is complementary and coordinated which assures national uniformity and equity in the management of pesticide risks to ground water.

In the proposed strategy, EPA recognizes that pesticide risks to ground water are manageable. The focus of the strategy, however, is almost entirely on nonpoint sources associated with the application of pesticides. EPA establishes this focus by referencing rather general and misleading statements such as:

> "By 1986, a total of 19 different pesticides had been detected in ground water in 24 states where the source of the contaminant was probably a result of agricultural application (nonpoint source) rather than from spills or other point sources of pesticides (Table I-3 and Figure I-4). It is important to note that ground water contamination resulting from normal pesticide use applications may occur over large geographical areas and result in exposures to large segments of the population" (p. 21-22).

Current surveys conducted in various states are indicating that point sources such as spills, vulnerable mixing and loading areas, back-siphoning, and direct routes for surface water movement into ground water, e.g. sinkholes and agricultural drainage wells, are often the cause of pesticides reaching ground water.

In reality, the extent in which pesticides are getting into ground water and the causes are not well understood. With the expansion of monitoring activities in both the private and public sectors, it is important that greater attention be placed on investigating why any pesticide that is found in ground water got there. If we are to effectively prevent future occurrences of pesticides or any other substances in ground water, then the causes of past occurrences must be properly identified and corrected, whether they be of point source or nonpoint source origin. Also, as our understanding of the overall "problem" improves, it is essential that our attention and resources focus on those areas which are most significant in risk to health and the environment. It is extremely important that in designing and implementing ground water management programs, emotions and incorrect perceptions be kept to a minimum. Anything that can become a serious obstacle or cause misdirection to effective ground water management must be avoided.

Although the strategy contains no definition for "contamination", EPA's general use of it infers even the mere presence of any foreign substance in ground water. NACA is concerned with the presentation of "contamination" in this context because of the common public perception of contamination being "unfit for use". We believe that EPA needs to address the communicative affects of "contamination" as it is presented in the strategy relative to the varied uses of ground water.

NACA applauds EPA for the job it has done in drafting the proposed strategy. The strategy has taken a very complex issue and put it into a comprehensive and understandable text which provides the public the opportunity to evaluate and comment. The comments attached hereto are intended to build on the strategy to assure that pesticide risks are effectively and efficiently managed. We stand ready to assist EPA in furthering the development of this strategy, and in particular, defining the registrants' role and responsibilities.

Sincerely,

Thomas J. Gilding

Thomas J. Gilding
Director of Environmental Affairs

TJG:pmc

Enclosure

NATIONAL AGRICULTURAL CHEMICALS ASSOCIATION'S* COMMENTS ON EPA'S AGRICULTURAL CHEMICALS IN GROUND WATER: PROPOSED PESTICIDE STRATEGY

June 24, 1988

Introduction

The agricultural chemicals industry is firmly committed to the protection of ground water resources, and as such is in basic agreement with the overall objective of the strategy -- prevention of unacceptable risks to ground water to maintain its varied and valued uses for current and future generations. The sound management of risks to ground water demands consideration of its use, value, and vulnerability. Relative to pesticide risks, these considerations, along with the benefits of pesticides, provide a sound basis from which to guide the judicious expenditure of resources towards the optimum protection of ground water and the safe and beneficial use of pesticides. Any regulatory action which can result in the arbitrary and inequitable removal of pesticides as viable economic tools in agricultural production, must be avoided. The strategy, as finalized, needs to maintain the weighing of the risks and benefits from pesticide use in determining when regulatory responses should be initiated and to what degree.

NACA is pleased to present its comments to the proposed strategy. The comments are organized under the following issues:

1. State Management Plans
2. Management Reference Points
3. Prevention
4. Differential Protection
5. Geographic Restrictions
6. Generic National Controls
7. Monitoring and Early-Warning Systems
8. Resources for Users Decision-making
9. Research and Development Priorities

ISSUE: State Management Plans

COMMENTS:

NACA recognizes the role and responsibility of states in managing ground waters within their boundaries. Complementing this, the federal government should provide the necessary technical and financial assistance with the primary objectives of providing guidance, supplementing critical resources, and minimizing unnecessary or duplicative efforts. Certainly, a very important federal role is in the oversight capacity to assure that individual state efforts achieve a minimum level of acceptable performance and preclude potentials for economic inequities resulting from differing state approaches.

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* The National Agricultural Chemicals Association (NACA) is a nonprofit, trade organization of manufacturers and formulators of pest control products employed in agricultural production. NACA's membership is composed of the companies which produce and sell virtually all of the technical crop protection materials (active ingredients) and a large percentage of the formulated products registered for use in the United States.

The maintenance of national uniformity in the regulation of pesticides is paramount to their safe and beneficial use. Should significant variations exist in state ground water management plans, economical inequities to effected agricultural producers could result. The presence of management plans with differing baselines for assessing risks to ground water and initiating regulatory responses could cause unreasonable and unnecessary burdens on pesticide registrants in registering their products and present obstacles in the development of educational materials for the pesticide user.

NACA recommends that the final strategy strongly embraces the goal of uniformity in regulating pesticide risks to ground water. Such a goal can be achieved through an oversight role of EPA in the state plan development and implementation process. In this role, EPA could provide clear technical and administrative guidance to states by defining the essential components of effective ground water management. NACA presents the following components as the basis for sound state ground water management programs:

1. Existence of state legislative authority for carrying out its responsibilities for the development, implementation and enforcement of a state plan.

2. Requirement for a memorandum of understanding (MOU) between the various agencies of the state to define and coordinate their respective responsibilities in the administration and enforcement of a state plan.

3. Adoption of EPA criteria for assessing ground water vulnerability in local agricultural areas.

4. Requirement for mapping of agricultural areas according to ground water vulnerability and uses.

5. Adoption of EPA criteria for designing and initiating ground water monitoring programs.

6. Adoption of EPA quality control protocols for ground water sampling and analysis.

7. Adoption of generic management practices for controlling point sources of pesticide contamination, e.g. pesticide mix/load areas, spills, improper waste disposal, back-siphoning, or surface run-off into wells.

EPA, utilizing USGS, USDA, and registrants as its primary technical resources, should be responsible for providing technical guidance in the development and implementation of state plans. The area where NACA believes technical assistance is of most importance is in the establishment of methodologies for relating pesticide leaching potential to localized site conditions to provide meaningful perspectives for risk management decision-making. The NACA comments further discuss this under the issue: Monitoring and Early-Warning Systems.

One major concern of NACA with the state plan approach as EPA discusses in the strategy, is the consideration of banning a pesticide in a state, should that state, for whatever reasons, not have an approved state management plan. There could be many reasons why a state may not have an "approved" state plan. This provision, if put into effect, could force important pesticides off the market simply due to bureaucratic failures alone. NACA does not support any mandatory removal of a pesticide from the market without adequate consideration to whether a risk to ground water is actually present and the economic impact to the state(s) and agriculture producers involved. This provision to ban pesticides in the absence of state plans is fundamentally unfair to farmers and pesticide registrants alike. It would penalize them for actions over which they have no control. The quantity and quality of crop production in an entire state could be damaged simply because of inadequate agency staffing, foot dragging, or any other factors contributing to the reason for a state's failure to have an acceptable management plan.

ISSUE: Management Reference Points

COMMENTS:

The establishment of uniform national standards as management reference points for pesticides in ground water is critical to the successful implementation of the proposed strategy. EPA is correct in identifying the Maximum Contaminant Level (MCL), promulgated under the Safe Drinking Water Act, as the management reference point to be applied to drinking water. MCLs represent the enforceable standards of purity for public drinking water.

NACA believes that exceedence of the MCL should be the "trigger" for regulatory action. The actual initiation and level of regulatory response should consider the geographic and toxicological significance of the risks, the use, value and vulnerability of the effected ground water and the benefits of the pesticide involved. EPA recognizes this risk/benefit tailored response as an integral part of "differential protection". Any level less than the MCL is not appropriate as a "trigger" for regulatory action. No such level is used in the Safe Drinking Water Act.

NACA recommends that EPA more clearly define the approach for establishing management reference points for those pesticides for which no MCL exists. First of all, NACA believes that EPA should make every effort feasible to expedite the MCL process for pesticides. EPA should promulgate the applicable MCLs on an accelerated schedule, perhaps giving priority to those pesticides for which there is evidence, substantiated by monitoring data, of having greater leaching potentials under application conditions.

For pesticides where MCLs do not exist, NACA supports the use of the Health Advisory as an interim management reference point. EPA has recently published draft Health Advisories for 62 pesticides in preparation for its National Pesticide Survey. These health based numbers address the toxicological significance of pesticide residues in drinking water, but are not promulgated through rulemaking and not enforceable. NACA, therefore, recommends that EPA adopt Health Advisories through a rulemaking process. This process will provide for the opportunity for public comment and judicial review.

ISSUE: Prevention

COMMENTS:

Sound and effective management policy has to be based upon goals which are realistically compatible with human existence in a high technological society. Many aspects of modern life adversely effect the quality of ground water, including its use for drinking. Preventing contaminants from reaching or exceeding management reference points, i.e. MCLs, provides a sound and comprehensive basis for protecting ground water for use in future generations, yet allows continued advancement in our quality of life.

Preventing contaminants from exceeding management reference point should not be viewed as "not protecting" or "writing-off" any ground water. Implementing this prevention concept to the maximum feasible and practical extent will provide the baseline from which effective ground water management results can evolve. NACA is convinced that much can be done through educational and other nonregulatory strategies to eliminate those conditions or practices which significantly increase the potential for pesticide residues to reach ground water.

ISSUE: Differential Protection

COMMENTS:

The concept of "differential protection" as presented in the proposed strategy provides the opportunity for sound science to be used in managing pesticide risks to ground water. This is particularly important because of the wide variations of application conditions and ground water use, value, and vulnerability that are experienced in pesticide use. Although significant needs exist for technical guidance in the implementation of differential protection, it does represent the only logical approach for society to consciously manage a resource based on controlled risks and recognized benefits.

Upon reading the strategy, the "use" and "value" of ground water appears to be given primary consideration for making management decisions based on differential protection. Occasional mention is given to ground water vulnerability in the strategy discussions. The vulnerability of ground water to contamination is an important factor in determining management responses to pesticide risks to ground water, and therefore, should be addressed simultaneously with ground water use, and value. With respect to pesticide risks to ground water, vulnerability provides an indication of the likelihood that pesticide residues will reach ground water for any given combination of pesticide/application conditions associated with normal pesticide applications. The likelihood of occurrence is an important factor that must be considered in assessing the need and severity of management responses from the risk side of the risk/benefit equation. The use and value of ground water, along with the concentration and toxicity of the pesticide, determines the significance of the resulting risks.

NACA supports the classification of drinking water as the highest beneficial use of ground water. We also recognize and support the classification of ground water according to other uses and values, but have the following major concerns about the classification approach as identified in the strategy.

1. Although NACA recognizes the need and importance for protecting ecologically significant areas, this classification could easily be misused. The best approach to resolving this issue would be to focus on the question of use areas versus recharge areas. For example, an aquifer which supplies a portion of the water supply to a small area considered to be of special ecological importance may have a recharge area covering hundreds of square miles. Pesticide use over the major portion of the recharge area would have little impact on the quality of the water flowing through the area of concern, but could be unnecessarily restricted under the proposed strategy. A better

approach to insuring the quality of ground water in ecologically important areas would be to utilize reasonable, scientifically-based buffer zones and carefully manage all activities in these zones.

2. Additional hydrologic criteria should be considered in the classification of ground water. Many ground water sources are unsuitable as drinking water supplies due to such hydrologic characteristics as limited seasonal and extremely low flow or yield rates. The strategy should focus on drinking water provided by aquifers which are best defined as:

   > An underground, saturated, permeable, geologic formation capable of producing significant quantities of water to a well or spring. It is the ability of the saturated zone, or a portion of that zone, to yield water which makes it an aquifer. (American Chemical Society, 1983, Groundwater, ACS Dept of Public Affairs, Washington, D.C.) Although temporary or seasonal ground water sources such as seeps may be intercepted by poorly designed wells, a well used to supply drinking water could not rely solely on these sources and the contribution to the total well volume would typically be small.

3. The expected future use of the ground water should be recognized as suggested in the strategy. NACA supports the differentiation of ground waters that occur in areas which have a long history and expected future of agricultural use. This classification should be expanded to those areas which will likely remain as forest or range.

ISSUE: Geographic Restrictions

COMMENTS:

The proposed strategy identifies geographic restrictions on pesticide use as one approach to prevention. NACA agrees that geographic restrictions are a viable option for protecting ground water, but is concerned that the ease of implementation invites extended and unnecessary applications. This could result in some pesticides being removed from use in significantly large geographic areas where such action is not warranted.

In considering the use of geographic restrictions, EPA should establish criteria and guidance on what conditions warrant this type of regulatory response. As an example, this criteria needs to address the percentage of an area that is occupied by "vulnerable" ground water areas. The ground water use(s) for the area must also be determined.

In addition, geographic restrictions can have a potential for introducing negative affects on educational programs for pesticide users. If pesticide use is managed by this approach, the pesticide user may not understand why ground water supplies are more vulnerable at particular sites. Also, in the process of rating an entire area, a certain degree of generalization is necessary with the end result being a higher inference of the potential for a pesticide to reach ground water than what is actually the case. Another, but opposite, problem could occur when the public is led to believe that any pesticide applied, spilled, or disposed cannot reach the ground water within a geographic unit mapped as having low ground water vulnerability.

The use of more detailed geographic characterizations is important in improving the realistic response of geographical restrictions. In addition to physical and spatial identification of local soil types, information on landscape profiles to permit pesticide users to more easily identify vulnerable locations of concern, is important. The availability of computerized soil survey information from the USDA Soil Conservation Service would allow EPA to develop appropriate site characterizations for the various use regions. When combined with the ground water information provided by the states, the site characterizations would allow pesticide users to implement more localized and effective management practices.

ISSUE: Generic National Controls

COMMENTS:

In general, generic national controls are not appropriate to the localized conditions of pesticide application. As discussed throughout these comments, effective management of pesticide risks to ground water associated with application nonpoint sources, must address the site specific nature of the application conditions in combination with the properties of pesticides in question, including use patterns and seasonal timing of application. To do otherwise, would only result in sacrificing the quality of effective management strategies for simplicity of implementation.

The use of generic controls, however, is adaptable to those practices or situations which are potential point sources of pesticide contamination. Pesticide spills, improper well designs and construction, improper handling of pesticides during mixing and loading, waste disposal, etc., are all examples where generic national controls could effectively be applied. The purpose of these generic controls should be to establish and foster uniform performance criteria in the control of point sources.

Specific to pesticide waste disposal, NACA, along with representatives from EPA, USDA, state pesticide and hazardous wastes regulators, pesticide user groups, and academic researchers, has been actively involved during the last three years in defining recommended regulatory and nonregulatory strategies for managing pesticide wastes. Written proceedings from two separate national conferences were published by EPA. (EPA Proceedings: National Workshop on Pesticide Waste Disposal, September 1985 (Doc #EPA/600/9-85/030) and September 1987 (Doc #EPA/600/9-87/001)) A final report on four regional workshops which were held as follow-ups to the conferences will be available soon.

ISSUE: Monitoring and Early-Warning Systems

COMMENTS:

A major concern that NACA has with the monitoring portion of the strategy is that it is extremely vague. We realize that by nature, strategies contain many generalizations, but the success of monitoring programs is extremely critical which necessitates the need for design criteria to be in more detail to include the following considerations:

1. If no evidence of ground water contamination exists for a given pesticide, prospective monitoring should be limited in scope and duration. Extensive monitoring programs would only result in unreasonable costs to registrants and would probably yield little new information beyond the data submitted for registration. EPA is currently increasing its FIFRA data requirements on leaching potentials to support new or existing registrations of pesticides. If these data requirements are properly defined and the resulting data effectively used, large-scale monitoring as an added check would be an unnecessary duplication of effort. Rather than relying on extensive monitoring, additional emphasis should be given to improving field studies and modeling efforts which would provide an adequate level of confidence in support of registration.

2. If monitoring is determined to be necessary to evaluate the extent of possible contamination, then extensive sampling should only be required if the pattern of occurrence clearly indicates nonpoint source leaching. The presence of a pesticide in a single well or sporadic findings in isolated wells, does not necessarily indicate widespread leaching over an entire use area and could likely be the result of point source contributions.

3. The type and source of ground water monitoring data should be considered in the development of any decision in response to positive detections of pesticides in ground water. Samples from a monitoring well which

intercepts a shallow ground water layer in the center of a treated field or from a shallow, poorly constructed well that is likely to be affected by runoff or shallow seepage should not be given the same weighing as samples obtained from properly constructed domestic or irrigation wells. Any large-scale monitoring programs should also be limited to domestic or irrigation wells which have been installed according to accepted standards.

4. The type of regulatory responses which are considered appropriate to the varying levels of risk that could result from monitoring programs is not adequately addressed in the strategy. EPA needs to provide proper guidance to states in defining responses to pesticide detections in ground water. This guidance needs to insure a uniform and scientifically-based approach to pesticide detections, consistent with the risks involved.

ISSUE: Resources for Users' Decision-making

COMMENTS:

Proper education is a key to preventing pesticides or any other substance from reaching ground water. Obviously, the major issues associated with the implementation of effective education programs center around determining: 1) the kind of decisions that pesticide users can be reasonably expected to make; 2) the type of information necessary to support this decision-making; and 3) the responsibilities for developing and disseminating information to pesticide users.

NACA supports expanded education and training to provide pesticide users the necessary resources to manage the safe and beneficial use of pesticides. To achieve this goal with respect to ground water protection, pesticide users need to have a working knowledge and understanding of the environmental behavior of the pesticides they use under the kinds of application conditions represented in their agricultural operations. The relationships and affects of the soil types, water management, and application practices on the mobility of their pesticides are of particular importance. To enhance this capability of pesticide users, greater spatial consideration to the soil properties affecting pesticide mobility and ground water vulnerability will be necessary. Perhaps the assistance from local officials such as soil and water conservation district representatives could provide the necessary resources for this capability.

The task of educating pesticide users should be shared by the EPA, USDA (Cooperative Extension and Soil Conservation Services) and registrants. There should be a coordinated effort between these entities in defining the necessary content of the educational programs, their respective responsibilities for developing and disseminating the materials.

NACA supports an active role by the registrants in the educational process as part of their individual product stewardship and FIFRA labeling initiatives. Registrants, as separate companies, can utilize their established channels of communication for disseminating educational materials to their customers. Documents providing supplementing label information, i.e. Generic Users Manual under consideration by NACA in cooperation with EPA, could be very effective in disseminating relevant information to pesticide users on ground water protection. Certified applicator training programs are another means for disseminating ground water related information to pesticide users.

ISSUE: Research and Development Priorities

COMMENTS:

Research and development has a very important role in bringing about greater capabilities in the effective management of our ground water resources. The primary areas in which research and development can make significant contributions are:

1. Improved pesticide adsorption/desorption and degradation profiles in the varied "real world" application conditions;
2. Computer modeling for simulating the transport and degradation characteristics of pesticides in given hydrogeological settings and application conditions'
3. Sound crop, soil and water management practices for minimizing those situations which potentially drive certain pesticides under certain conditions to reach ground water from normal use; and
4. Protocols for characterizing ground water (mapping) according to its levels of vulnerability to contamination.

Although much is known about the environmental fate of individual pesticides, there is a need to better understand their mobility and degradation responses within the wide range of application conditions. This kind of information is of particular importance as input data for computer modeling and for making process assumptions in setting up modeling scenarios.

Computer modeling technology offers great potential as a research and management tool in protecting ground water from potential pesticide risks. If risks associated with the use of pesticides are to be effectively identified, evaluated, and managed, then we must have the capability for identifying those combinations of pesticide properties, application conditions, and agronomic practices to prevent pesticides from reaching ground water and exceeding their management reference point. The application of this technology as a management tool has great value in: 1) designing new products or modifying existing formulations relative to leaching considerations; 2) serving as a viable cost effective surrogate to actual field monitoring; 3) assessing pesticide risks for regulatory purposes; 4) identifying and evaluating improved management practices for minimizing leaching potentials; and 5) providing educational and management information to pesticide users.

The major obstacle to advancing computer modeling technology is the lack of realistic and representative input data to support the various applications. Properly defined research can play an important role in bringing computer modeling capabilities into the operational reaches of ground water managers. In order to simulate the transport and degradation properties of pesticides in varying hydrogeological settings, research has to concentrate on the complex interactions between the various combinations of water flow processes, site characteristics including depth to water table, and pesticide properties. The application of this information on a geographic basis demands that relevant hydrogeological data be presented from a spatial perspective.

NACA was instrumental in organizing a workshop under the sponsorship of the Agricultural Research Institute (ARI) to identify the research needs in computer modeling for agricultural chemicals. The workshop, titled "Research Needs for Unsaturated Zone Transport Modeling of Agricultural Chemicals" was held on November 2-4, 1987. The proceedings are presently available from ARI.

Characterizing the vulnerability of ground water on a localized basis is a critical component to sound ground water management. By knowing locations where ground water is at greatest risk because of certain hydrogeological factors, judicious resource expenditures in implementing management strategies is maximized. The understanding of vulnerability is also a critical component the adoption of effective management strategies by pesticide users. Although not necessarily research in nature, methodologies are needed for arranging hydrogeological data into a meaningful presentation for mapping ground water vulnerability.

Approaches for assessing ground water vulnerability do currently exist. EPA's use of the system called "DRASTIC" is representative of a general screening approach for characterizing and mapping ground water vulnerability. Although DRASTIC could possibly be used on a more local, site specific scale, the question of whether some other systems might be more compatible to the needs of pesticide users, i.e. less technical and labor burden.

The research needed in characterizing ground water vulnerability should focus on the spatial and temporal variability that may be present in ground water recharge. A better understanding of these variability factors is needed for enhancing ground water vulnerability assessments.

Mr. **Clinger**. Mr. Hind.

Mr. **Hind**. We, and other environmental groups who signed onto our testimonies today, have either commented formally or informally our displeasure with the strategy. It is largely the same as it was proposed last June even after the workshop in West Virginia.

One of the big problems we had that I cited earlier relates to the prior question "negligible risk," which really translates to maximum contaminant levels being set for regulating pesticides. One reason we have a problem with that—Diane Baxter pointed out in detail—is it defies common sense. On the one hand we're saying we want to use MCL's because we're used to using them. We're comfortable with them. They're in the Safe Drinking Water Act. That's the legal limit for drinking water levels.

But in this case we're talking about the pesticides use regulations. We're talking about the amount of chemicals we're allowed to introduce into the ground water. We're talking about whether or not we are going to pollute up to a certain point. That's really what it comes down to. In the case of the Safe Drinking Water Act, you're talking about how much are you going to spend on technology to clean up already polluted water coming out of a river or whatever before it's considered usable for the water user.

But with pesticide policy now, at an early point in terms of ground water protection, we have a unique opportunity for prevention. To use these old technology driven standards instead of a prevention oriented standard that is health-based instead of technology-based, defies common sense. I think it will leave us behind when we start looking at, as you, Mr. Chairman, earlier eluded the European community. The European community, in general, is asking for a high standard of protection on ground water from pesticides. In Holland, as I understand it, they are now implementing a policy of a fraction of a part per billion, 0.1 part per billion for any one pesticide in ground water in Holland, and 0.5 parts per billion for all aggregate or cumulative numbers of pesticides.

I think that's an important development. Again, when we regulate a pesticide, we're talking about problem pesticides like alachlor are widely used with other chemicals as well. Earlier, the industry representatives pointed out that strict standards are somehow impractical or impossible to meet. Well, you can't have it both ways. On the one hand, we hear from industry that there's not really a problem except for some spills and some cracked wells, and on the other hand, zero is unattainable. That, to me, implies that we've got a widespread nonpoint pollution problem because of leaching from the billions of pounds normally used pesticides that are now being applied each year. If spills were the only problem, we would simply rely on existing cleanup statutes.

One major problem with the Agency ground water strategy is the standard setting. But the other major problem is the triage approach to ground water. To say to a State, if you want to write off ground water for drinking water in the future, and you know somehow that that land will never be used—or won't be used in the near future any way—for housing, building shopping malls, or other uses that will draw upon its water for drinking, for livestock, or others, then you can write that ground water off. We think that that's a major mistake. Right now we not only don't know much about the nature of ground water, we certainly can't predict its future and the nature of it.

Again, a reminder that ground water contamination travels "in plumes." I think you can think in terms of a python swallowing its victim. The beginning of the contamination may be small, maybe a part per trillion, but chances are it will only increase. I cited the example of DBCP in California increasing eight years after the chemical was no longer used. Hopefully, eventually, that contamination level will decrease. But at this point, we're just substituting or increasing the problem with new chemicals, especially if we set standards that allow for high levels of pollution, or allow for widespread pollution by writing off entire portions of aquifers.

Mr. **Clinger**. You allude to the fact that we really still have a great deal to learn and to discover about ground water. One of the things that struck me today is what we know about how much of this is caused by point source pollution, and how much is by nonpoint source pollution. Apparently, there is really no easy way to determine that.

The question I have is: are we really in a position to formulate policy in this area without that kind of data? Do we have enough data at this point to really go forward, confident that we can develop a strategy that is indeed going to address the problem or not? Anybody?

Mr. **Early**. I'll comment on that. EPA, as I said, has developed a ground water strategy that I very much support and welcomed. I don't really think that means that the EPA strategy today is necessarily going to be the same one they're going to have 5 years or 10 years down the road. Based on my experience with EPA, it's a constantly moving issue over there as we become smarter and have more technology. As we learn more about it from their well water survey, or as other information comes in, it's logical that one would change their strategy, or their techniques, or whatever you'd like to do to correct the situation.

But I think to wait around and not have a strategy at all is also foolish. So I think what they're doing—although we all may have a little bit of concern about how it's done—at least they're taking some positive action. They're doing something. They're putting something down in writing and saying this is what we're going to do for right now.

Mr. **Clinger**. Mr. Maslyn, in your statement, you cite the fact that there is growing evidence that ground water contamination is caused by a number of variables. You stress the fact that it is site-specific and that there are differing conditions depending on where you are. You include variables unrelated to the basic properties or leaching susceptibility of the chemical itself. If those variables are indeed relevant, what does that say about the viability of a national regulatory program with national standards uniformly applied? How do we reconcile the fact that this is a site-specific program with variables that are unrelated to the chemicals with a national regulatory program and uniform standards?

Mr. **Maslyn**. Well, I think what it tells us is that a critical element in whatever kind of protection strategy or regulatory program we put in place has got to be information, education, and training, an awareness effort on the part of the user. That was the purpose of a couple of the publications we put together, to make growers aware of the fact that just the mere act of putting something on the soil is not the only potential source of contamination.

A lot of this effort is going to have to be self-policing. I think the agricultural community is an appropriate place for that to take place. I don't think anybody is going to be more concerned about the potential for ground water contamination than the farmer himself. He lives in that environment. It affects his property value. It could affect his health. It affects his livelihood.

He is going to be concerned with the potential degradation of that resource regardless of the cause or source of that contamination, whether it is a spill at the mixing/loading site, or whether it is the nature of the hydrogeologic conditions on his farm, the soil conditions, or whether it is a leaking underground fuel tank that he has. He is going to be concerned.

It is the responsibility of us and the public policymakers to make sure that he has the tools to become informed and make those educated decisions.

Mr. CLINGER. Did I understand that both the Farmers Union and the Farm Bureau officially support the low input production farming initiatives that are being implemented presently by the USDA?

Mr. MASLYN. Yes, sir.

Mr. MORSE. Yes. On behalf of the Farmers Union, I wholeheartedly say, yes, we endorse that.

One of the strategies to be developed in addition to the EPA ground water strategy—I did mention some of them in my testimony, such as not necessarily county by county, but taking susceptible areas out of agricultural production, restricting the use of chemicals in those areas, and dealing with some of the other sources of pollution that we are sure of, such as abandoned wells. There are a number of steps that we can take that we do not need any information on to go forward on. We need no more information to go forward on those.

Mr. CLINGER. I have just one final question. Dr. Early, in your statement, you cite the development of health advisories as a trigger for regulatory efforts and as a means of public education. You also cite the addition of a "severalfold safety factor."

Mr. EARLY. Yes.

Mr. CLINGER. I wonder if you could amplify on what you mean by "severalfold safety factor."

Mr. EARLY. Let me do that. If I need some help from the toxicologist behind me, I will pull him up here.

When you establish these numbers, you go through a whole series of animal toxicology studies with rats, mice, dogs, and everything else over a period of time. You try to establish what I would refer to as a "no effect level"—no observable effect on the animal.

Once you arrive at that level with those series of animals that you are testing, then normally you would crank into that factor a hundredfold and sometimes as much as a thousandfold factor. This gives you a little cushion in between that says, all right, you have arrived at a point where the toxin has no effect on the animal. Hopefully that is transferrable to humans. That is the reason we do this, of course. Once we arrive at that number, then we will give ourselves another hundredfold or thousandfold factor just in case.

So this is what I was referring to, this cushion in here which we very much support. I think it is supported in the scientific community. We do that routinely and have for years in the areas of pesticides on food. We will establish tolerances on food. Certain levels are allowed. Then we crank in the additional safety factor. That is what I meant in that process.

Mr. **Clinger**. Thank you, Mr. Chairman.

Mr. **Oberstar**. Thank you very much, Mr. Clinger. You are always perceptive at questions and contributions.

Given the high cost of testing estimates from $900 million to over $2 billion for testing the wells to determine what their condition might be, is it possible to develop a soils-based prioritizing system for well testing, or a vulnerable chemicals-based system for prioritizing the testing? Is there some way that we can get at this matter by looking at those soils that are the most vulnerable and the chemicals that are most likely to penetrate through aquifers? Mr. Hind.

Mr. **Hind**. Mr. Chairman, I think the EPA earlier today alluded to the fact that their survey is providing us with new technology or new methodology in terms of multiresidue testing and so forth. But I think the problem is that—from what I know about the Agency's difficulty in determining leaching—they said today they know of certain potential leachers, over a hundred. The laboratory is not necessarily reliable in predicting what will leach. Then what happens in the real world also may differ.

Dr. Charles Benbrook at the National Academy of Science is talking about how the chemicals—even in no till farming areas where you would expect, perhaps, less of a leaching potential because you are not tilling the soil each year—are penetrating the soil through worm holes, root canals, and so forth in the soil. Dr. Baxter pointed out that some are actually designed to do that.

So we would argue—and to make up for my hesitation before—we need a prevention program which then has incorporated in it much more monitoring, both on a national representative level as well as site-specific where monitoring does take place. If monitoring turns up certain residues in certain levels, people in that area should be able to get more monitoring as well as national representative monitoring to determine, as you have alluded to, different geologies and hydrologies which may indicate where chemicals should never be considered or where different management practices may be considered. I think those things are wisely taken into consideration in H.R. 3174.

We would also point out in those requirements that the manufacturer is the responsible party for conducting that monitoring so that neither the State or local government is burdened with that. However, we encourage State and local monitoring as well to advance our knowledge of unknown aquifers.

Mr. **Oberstar**. Thank you.

Dr. Early.

Mr. **Early**. I was going back to Dr. Oliver behind me. I was going to ask him if he could respond as to what we are going to be learning through this survey and through some of the modeling, and how we are going to be able to predict issues a little more in the future. If I could get Dr. Oliver to comment on that, I would appreciate it.

Mr. **Oberstar**. Yes.

[Witness sworn.]

Mr. **Oliver**. In terms of using a scientific base to know what to look for and where to look for it, you definitely can do that. To a large extent, that is what the pesticide survey is trying to do. They are concentrating in areas where they think there is the greatest chance.

The chance for a chemical—and that is any chemical, not just pesticides—to reach the ground water is based on three things: the chemical properties itself, the environmental conditions where it is used, and how it is used. So you really need to look at all of those.

The basic laboratory studies give us an idea of what the properties are of that chemical. Is it going to break down quickly? Is it going to be strongly bound to the soil? We then do field studies to look and see if that is what really happens in the field. What we see in the laboratory, can it translate to the field? So we have that information.

We know what chemicals are more likely to move. But you have to remember that may be under particular use conditions. You also have to look at how the chemical is used. Is it applied in an excessively high rate, or is it a low rate? Some chemicals which appear to be very mobile are applied at such low rates that they just don't have enough chemical to reach great depths.

You also have to look at the environment condition. A chemical that may be more mobile may be able to be pushed deeper in higher rainfall areas. If you apply it in a low rainfall area, there just isn't enough water to percolate down and push the chemical down. So you really need to take all those factors into consideration.

With the advances in computer modeling, we are able to do that. We can take and put all these factors together and you can get an idea of what chemicals in what areas would probably represent the greatest chance of reaching ground water. Those are the ones that should be looked for and in those areas. So you can well design a monitoring study based on that information.

There is always a chance in another case that someone might spill it down a well, or that it may be thrown in a sinkhole. Things like sinkholes, they are going to be a problem everywhere. No matter what you throw down it, it is going to end up in ground water.

But in terms of monitoring, I think we are already seeing the States, Minnesota, for example, concentrate their surveys in areas that they thought would have the greatest potential to reach ground water. I think we are seeing science entering the monitoring phase. That is where it should be.

Thank you.

Mr. **Oberstar**. Thank you. I appreciate that response.

Mr. Maslyn, would you like to respond?

Mr. **Maslyn**. I would also comment that eventually, someday, one of the great hopes of farmers and ranchers is that the prospect for computer modeling will be a reality and that farmers can, based on their own unique soils on their farm, plug into a computer, or call into the land grand university or through the Extension Service, with the input of certain information, be able to get an estimate or an impact statement as to what the potential of a particular pesticide would be to leach in their area on their type soils.

I could also comment on the strategy that the Agency has put. I think it fits fairly well with the EPA's agricultural chemicals ground water strategy in that, again, the emphasis is on the local, State conditions and the information that can be determined and provided by the State.

The State of Florida has very different environmental conditions—one of the three factors that was just mentioned—than the State of Arizona. Yet both are high and very productive vegetable growing areas. California is different still. It is important that we allow people at the local level, either the State or growers themselves, to be involved in this process to the greatest extent possible. The broad national decisions are made here in Washington based on a national perspective.

Mr. OBERSTAR. Well, we understand. It has been said several times that this needs to be a cooperative program. You certainly have underscored that factor.

Senator Morse, you are an apple grower. Apple trees don't move around very much. They sort of stay in one place, unlike other crops that may be rotated. What experience have you had in your own work with pesticides that obviously are applied, stay in one place, year after year, recur to the same tree? What experience with residues and uptake by tree itself? This is moving in another direction.

Senator MORSE. Mr. Chairman, that is a good question because we don't have that option of rotation. As a matter of fact, we have some trees that are in the seventh decade that we have held onto.

Unfortunately, I think you are getting at part of the problem. We have never done, in our own personal area, a test for all the chemicals that we could be using in our water supplies. We have a processing plant with a State test for selected chemicals. But part of the problem is that we do not have available to the citizen testing of private wells for agricultural chemicals.

I believe that in orchards we do not apply the chemicals to the ground. Our target, of course, is the tree. So we don't have as much of the leaching problem into the ground water directly. I would add that the products are tested by the State. Again, they test for very few chemicals; the USDA also. I can't tell you the exact levels, but we have never had a problem of residues in our fruit in violation of any statute. That is commonly what we find in our ground water also. But we do certainly have residues.

Mr. OBERSTAR. That's very interesting.

Mr. Maslyn, you addressed the issue of conservation tillage. We had a comment earlier from Mr. Hind about the movement of pesticides through—even in conservation tillage areas—the ground itself, just through worm holes and insect holes that burrow into the ground. What experience do you have with movement of pesticides through soils over a period of time that are under conservation tillage?

Mr. MASLYN. We don't have any data that would clearly indicate a problem. But I think it is very interesting that it was just a few years ago that this emphasis on minimum tillage, or reduced tillage, or conservation tillage, whatever you want to call it, was put forth. We in the Farm Bureau made a concerted effort through a program that we developed to go out and promote this idea of conservation tillage in order to reduce nonpoint source pollution.

We are seeing now the prospect, or at least concerns raised about the counterproductive effect of retaining this residue in the soil and perhaps exacerbating or leading to potential ground water problems. I listened this morning to the witnesses responding to a similar question. I don't think there is clear evidence out there to show that it is a problem, but it is certainly one that should be explored.

Mr. **Oberstar**. Mr. Hind.

Mr. **Hind**. The reason I raised not till farming was not so much to be critical. I think any new efforts in farming management or in soil management that we pursue is to be lauded. Even the EPA's ground water strategy pays some attention to the problem, which they admit is a real problem.

But I think it gets back to the question of what I have been hearing from other industry witnesses, which is that we don't have a nonpoint source problem, claiming we only have a point source problem, or that people who have shallow wells, or cracked well casings, and things like that.

I would just like to emphasize that our compilation of EPA's data—which they have alluded to repeatedly in public, but never in detail—finds 73 different pesticides in the ground water of 34 different States. These reports do not include point source contaminants. Those 73 pesticides in 34 States got there through normal agricultural use.

I point out also that one of the chemicals, aldacarb, which is found in 15 States, was supposedly one of the new "safe" chemicals that broke down quickly, had a short half-life. Now we find that when it is in an aquifer situation—in cooler, darkened waters—it can last. In a case of aldacarb in Long Island, they expect to have to filter people's water for the next 10 years to 25 years. Some people estimate that aldacarb or its degridants will remain in the ground water for 100 years. These degridants are just as dangerous as aldacarb itself.

In fact, in that particular situation, the level of ground water contamination decreased as they tested people's homes away from the potato fields. So the closer you were to the normal use of aldacarb, the higher the contamination levels found in well water was. So I think there is ample data to show that we have a problem from normal use of pesticides.

I also should point out that the video that will be given to the committee from the chemical industry, which I think is produced by the Soybean and Corn Growers Association, was criticized by EPA for failing to point out to the farmer the need to take extra care in ground water contamination from nonpoint sources. In other words, normal use of the pesticide, not just the spill, mixing, and loading situation which on its own, if you see the video, is dangerous enough. I think any farmer who avoids spilling or accidents has to go to great lengths.

So we are again reminded that we are dealing with inherently very dangerous, toxic chemicals. We would, in fact, implore the committee to address both nonpoint source problems through legislation, but also the point source problems more with the Clean Water Act and other appropriate laws that address cleanup.

Mr. OBERSTAR. Thank you very much.

The Chair would like to point out that the Chair attempted to set funds for the nonpoint source management program this year, but the Appropriations Committee saw otherwise. Even though funds were added in the Senate for a nonpoint source program, the Appropriations Committee chose not to accept that language in conference. I think this is a great mistake after spending years of bringing together so many elements in the agricultural community, forestry, and others who have agreed upon language which is now law, and then the committee wouldn't fund this. This is the new frontier in pollution abatement, a nonpoint source program. We had an opportunity to get things started this year. We will just continue to work towards that.

I have one last question that I wanted to address earlier. I would like a response from both Mr. Hind and Dr. Early.

What confidence do you have and what response do you have to EPA's advance testing program on new chemicals before they are marketed? What level of testing? What is your view of the effectiveness of this program? Dr. Baxter, you may be familiar with that and you may want to respond as well, and Dr. Early, your associate, too.

Mr. HIND. I think our major problem is—I don't want to cast aspersions on Dr. John Moore at EPA currently. In general, I think it is a very well-intentioned approach.

Our feeling and our fear from experience with the Agency gets back again to the issue of standards and the issue of what is actually mandated by Congress. Currently, there really isn't enough mandated by the Congress of the Agency regardless of what administration we are dealing with. As we saw with Superfund, there could be major malfeasance in the administration of the law.

In the case of pesticide contamination of ground water, where we are dealing with a similar kind of situation, although granting broad authority to the Agency, FIFRA does not have adequate mandatory authority that the Agency must live up to. Again, authority which I think would be provided in H.R. 3174 for everything from monitoring, to the triggers and best management practices, and so forth. So I think that is the key here.

I think from what we know privately, if the Environmental Protection Agency did not have some of the restrictions both bugetarily and politically from the White House, the people there right now would be pursuing a much more aggressive approach.

Mr. OBERSTAR. Thank you.

Dr. Early.

Mr. EARLY. Obviously, I disagree a little bit with Mr. Hind on this, Mr. Chairman.

As I mentioned earlier in my statement and comments here, the amount of health, safety, and environmental studies required by EPA today to register a pesticide to put it the marketplace is mind boggling. I would urge you and the staff to look at the kinds of studies and the tests that are required. It takes my companies over periods of 7 years, 8 years, 10 years to do all these studies.

Mr. **Oberstar**. Let me say that we shall do that in a subsequent hearing.

Mr. **Early**. I wish you would do that. You will get an appreciation of the kinds of studies that are being asked for to evaluate health, safety, and environmental issues out there.

Maybe the dollars are not an indication of it. But I have indicated that we are talking about $40 million, $50 million, $60 million worth of research. That is a lot of money.

In fact, if I may just add a little comment to that, the process of putting a new pesticide into the marketplace is becoming so expensive—and I will use the term, so risky, from an investment standpoint—that we are beginning to see mergers within our corporations. The number of companies that were in the research and development of pesticides just five or six years ago has reduced significantly. That is because the investment is so high. They say the financial risk is so high of staying in the business that we are seeing fewer and fewer people involved in the process.

It is a concern of mine. I think it is a concern of agriculture's too. The studies are extensive. Once you have a look at that, I hope you would agree with me.

Thank you.

[The prepared statements of Mr. Hind, Mr. Early, Senator Morse, Mr. Maslyn, and Ms. Baxter follow:]

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PESTICIDES IN GROUND WATER:
EPA FILES REVEAL
TIP OF A DEADLY ICEBERG

BY

RICK HIND AND ELIZA EVANS

SEPTEMBER 4, 1988

U.S. PIRG 215 Pennsylvania Avenue, S.E. Washington, D.C. 20003 (202) 546-9707

Findings

The following is a summary of the major findings from U.S. PIRG's study of the recently released data base on pesticides found in ground water at the Environmental Protection Agency's (EPA) public docket. (See map of U.S. and tables 1-5 attached for details.)

*** At least 73 different pesticides have been found in the ground water of 34 states.

*** The majority of detections of pesticides in ground water come from testing of drinking water wells; they include sampling of more than 2,500 wells in California and over 2,000 in New York (Long Island).

*** Ten states have eight or more pesticides in their ground water. California had the most, with 31 different pesticides reported in ground water.

*** Pesticides such as aldicarb and atrazine have been detected in 15 different states, indicating that many regions are susceptible to ground water contamination by certain pesticides.

*** Pesticide concentrations in ground water range from minimum detection levels to hundreds of parts per billion (ppb). For example, atrazine was found at 210 ppb in MI; aldicarb was found at 200 ppb in WI and as high as 575 ppb in NY; dacthal, also in NY, was found at 1,036 ppb.

*** Although for many of these pesticides there is incomplete human health information, at least 25 of the 73 in ground water are possible cacinogens, 18 can cause birth defects and 14 can cause genetic damage (see table 5).

The attached health-effects listed in table 5, largely based on "health advisories" issued by the EPA, provides a guide to the known or suspected impact of pesticides in ground water on human health. Where EPA advisories were lacking we used the 1985 Crop Protection Chemicals Reference book.

EPA officials estimate that over 5,000 out of 11,000 positive samples represented, in the files examined by U.S. PIRG, exceed some state or federal safety levels. New York State, for example, has set a safety level of 7 ppb for aldicarb.

However, under federal law, only six pesticide active ingredients have enforceable drinking water standards set under the Safe Drinking Water Act (SDWA), called "maximum contaminant levels" (MCLs). They are:

endrin at .2 ppb
lindane at 4 ppb
methoxychlor at 100 ppb
2,4-D at 100 ppb
Silvex at 10 ppb
toxaphene at 5 ppb

There are also nonenforceable health-based safety levels or "maximum contaminant level goals" (MCLGs) set under the federal SDWA. These are usually set at even lower levels, for example, .2 ppb for lindane; 34 ppb for methoxychlor; 70 ppb for 2,4-D; and zero ppb for toxaphene.

Background

In February, 1988 the EPA rereleased its "Agricultural Chemicals in Ground Water: Proposed Pesticide Strategy." The proposal was virtually identical to the version released in June, 1987. Regarding the number of pesticides found in the ground water of each state, the February proposal cited the same 19 pesticides found in the ground water of 24 states.

However, at the EPA's February press briefing on their proposed ground water strategy, Assistant Administrator for Pesticides and Toxic Substances, John Moore, cited a new total of 50 to 60 pesticides found in the ground water of 30 states. These new numbers sparked information requests from environmental groups, including a Freedom of Information Act Request (FOIA) from one group. The EPA still refused to release any information. Finally in March a group of environmental organizations formally requested the source of the Agency's new estimates of pesticides in ground water.

Responding to this request, the EPA created a public docket entitled Pesticides in Ground Water Data Base in early May (see May 10 letter from John Moore attached) which includes 101 studies conducted by state governments, chemical manufacturers, and other research institutions (such as the National Academy of Sciences). A complete index of these studies is also attached.

According to EPA officials these studies and reports represent more than 45,000 wells sampled, showing detectable levels of pesticides in about 11,000 wells, with about half of these (5,500) exceeding any federal or state safety levels. The EPA is reviewing this material and is not expected to issue its own summary until this fall at the earliest.

This report contains U.S. PIRG's review and analysis of EPA's Data Base, the details of which are listed in the attached tables and maps. Until 1990, when the EPA completes its first nationwide survey of pesticides in ground water, this compilation of studies in the Agency's public docket may be the most complete overview on the extent of the problem.

Conclusions

EPA's docket is by no means a complete picture of ground water contamination. Sixteen states are unaccounted for in the public docket, and information on some states is several years old. This study of EPA's docket files provides only a glimpse at what appears to be a growing national problem of pesticides in ground water.

Even the EPA recognizes that the findings contained in this report may be the tip of a toxic iceberg. For example, the EPA is slowly moving in several directions such as: their proposed pesticides in ground water stratey, regulations for pesticide use and they are currently conducting the first national survey of pesticides in ground water, to be completed in 1990.

The nature of the EPA survey already reveals more about the extent of pesticide contamination of ground water. EPA is sampling well water and analyzing it for 128 different pesticides (see attached EPA list). Of the 73 pesticides found in ground water according to EPA files, 29 are not even being tested for in EPA's on-going survey. Yet 32 of the 73 are among the 59 "priority potential leachers" included in EPA's search list of 128 pesticides. The Agency's survey is unfortunately not funded sufficiently to allow them to include testing for more dangerous pesticides such as lindane, malathion, methylene chloride, paraguat, parathion, TCP and toxaphene.

The reported number of pesticides in ground water and the number of states in which they are found is almost certain to increase when the EPA completes its survey for just 128 pesticides in ground water. Of the states with limited numbers of pesticides listed in ground water, several may eventually resemble states such as California, Iowa and New York where more thorough monitoring has revealed serious problems. For example, according to the Florida Department of Agriculture, 8 pesticides in addition to those reported on in the EPA docket have been found in Florida ground water.

Given the complex nature of hydro-geology and the unpredictable mobility and longevity of pesticides in ground water, even careful monitoring of ground water may underestimate the hazard. At best, monitoring is only a snap shot of the problem at the time of sampling. Ground water contamination occurs slowly and the impact on ground water from pesticides that are usually applied several times annually may not be known for years. But when the ground water is contaminated, unlike surface water pollution, it tends to concentrate rather than become diluted. For example, according to the State of California, dibromochloropropane (DBCP) levels were still increasing in ground water in Fresno County eight years after DBCP was banned. Although it appears that pesticides eventually break down into less harmful compounds, a 1986 National Acdemy of Sciences study pointed out that this can take ten to a hundred years.

Implications

In response to a problem that has reached crisis proportions in many states, the EPA recently stated in its proposed ground water strategy that "prevention of contamination must be the primary focus of protection efforts." However, when the EPA first applied this strategy to aldicarb in June, they proposed its continued use even after finding widespread contamination of drinking water wells by aldicarb over the last ten years. EPA also made it clear that they were not going to use the more protective health-based standards (MCLGs) to regulate pesticide use.

The EPA also proposed deferring regulation to the states and allowing them to "write-off" some ground water as unworthy of protection. The proposed EPA strategy has also embraced a policy of triage toward an almost irreplaceable natural resource. Many states are not ready for EPA's misguided proposal. For example, a recent General Accounting Office (GAO) report found that only 26 states now have ground water protection plans. Barring a stronger mandate and funding from the Congress, few states are likely to initiate or strengthen ground water protection unless they face the kind of crises that New York, Florida, California and Iowa are already facing.

While ground water is the source of drinking water for nearly half the U.S. (117 million people), the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and other federal statutes currently require little protection of this resource from pesticide contamination. Pesticide contamination of ground water is one of the most controversial pesticide issues now being debated in Congress. By the time the EPA releases its summary of their Data Base, which is not due until fall, Congress will likely have completed its consideration of FIFRA legislation for the year.

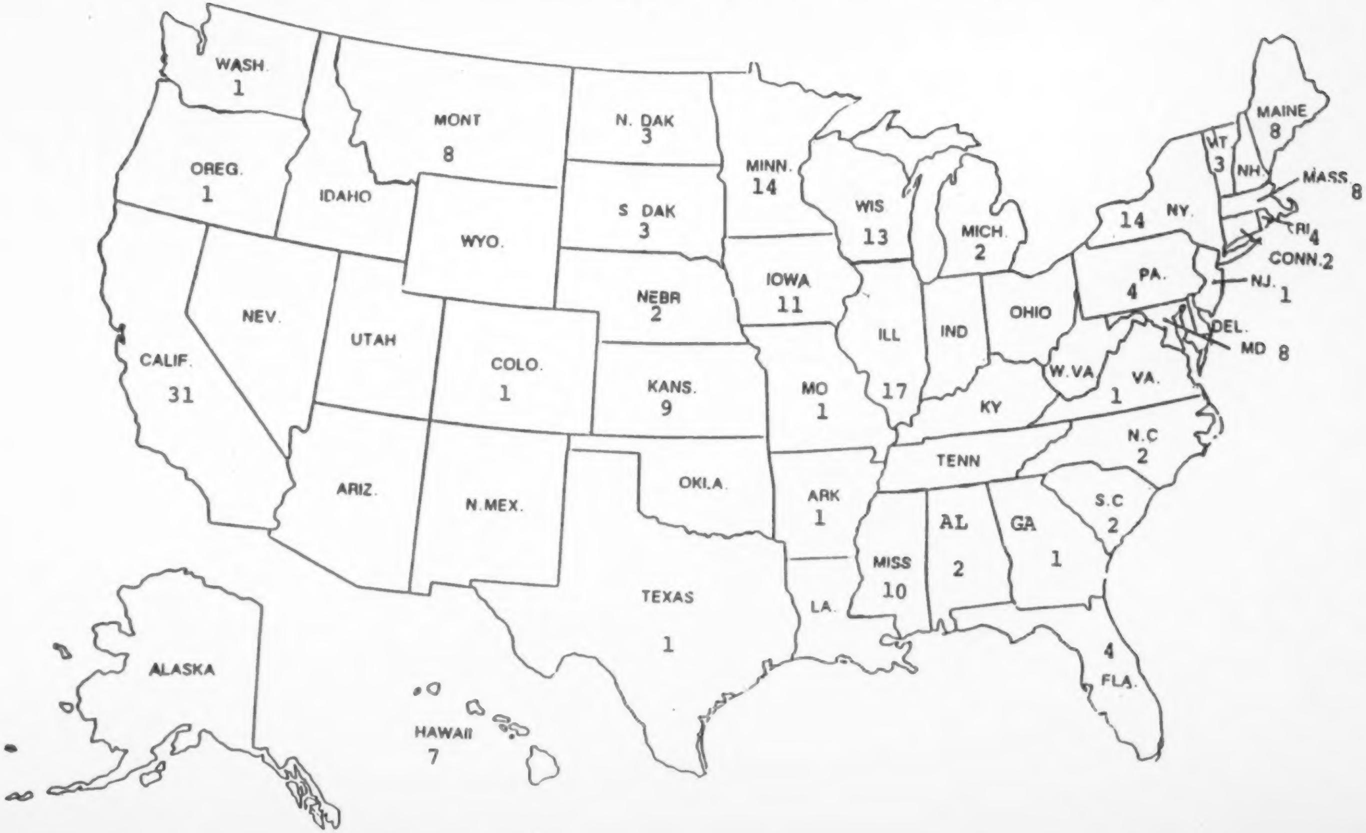
Of the ground water bills pending in Congress only two are prevention oriented. These bills are: H.R. 3174 authored by Representative James Oberstar (D-MN) and S. 1419 authored by Senator David Durenberger (R-MN).

Sources

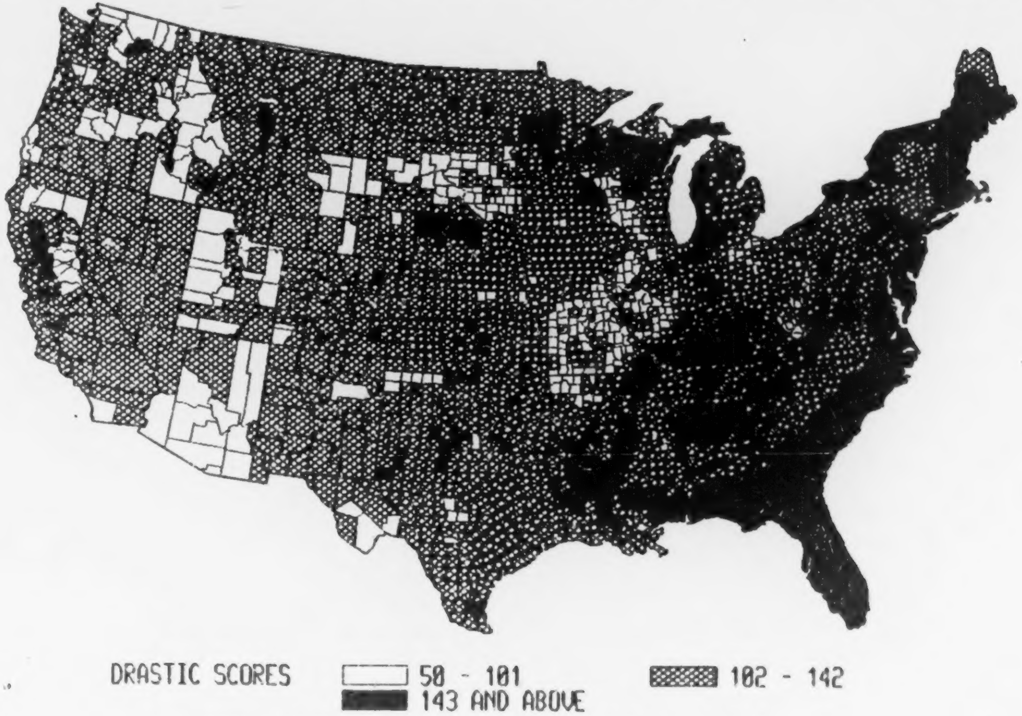
All information in tables 1-4 comes directly from 101 reports included in the EPA's public docket which contains the new Ground Water Data Base. A complete index of all the studies in the Data Base is in the appendix of this study. Table 5 lists known health effects for each pesticide. Other health effects were taken from the 1985 Crop Protection Chemicals Reference book. Many of the Data Base reports also identify the serious problem of pesticides found in ground water due to point source contamination (accidental spills, leaks etc.). For consistency this report does not include these in our study. Point source contamination accounts for at least another 10-20 additional pesticides found in ground water. Based on the reports and studies in EPA's Data Base, the ground water contamination summarized in this report is the result of normal agricultural use of pesticides.

Also included in the appendix are two maps. The first summarizes our findings, including the total number of pesticides found in each state's ground water. The second is EPA's DRASTIC (Depth in ground water, Recharge, Aquifer type, Soil type, Topography, Impact on vadose zone and aquifer Conductivity) map which shows areas of the U.S. that are most vulnerable to ground water contamination by pesticides. Other attachments include a chart compiled by the EPA that shows the relative reliance on ground water by states, EPA's list of 128 pesticides included in the on-going national survey and the May 10 letter from EPA's John Moore announcing the creation of the Data Base.

Numbers of Pesticides Found in Ground Water
As a Result of Agricultural Practice


WASH. 1
OREG. 1
CALIF. 31
IDAHO
NEV.
MONT 8
WYO.
UTAH
ARIZ.
COLO. 1
N. MEX.
N. DAK 3
S DAK 3
NEBR 2
KANS. 9
OKLA.
TEXAS 1
MINN. 14
IOWA 11
MO 1
ARK 1
LA.
WIS 13
ILL 17
MISS 10
MICH. 2
IND
KY
TENN
AL 2
OHIO
W. VA.
VA. 1
N.C 2
S.C 2
GA 1
4 FLA.
14 NY.
4 PA.
VT 3
NH
MAINE 8
MASS. 8
RI 4
CONN. 2
NJ. 1
DEL.
MD 8
ALASKA
HAWAII 7

DRASTIC EVALUATION OF THE UNITED STATES


DRASTIC SCORES
50 - 101
102 - 142
143 AND ABOVE

D-Depth to ground water
R-Recharge
A-Aquifer type
S-Soil type
T-Topography
I-Impact on vadose zone
C-Aquifer conductivity

Vulnerability of ground water to pesticides corresponds to higher scores.

Percentages Of People Relying On Ground Water For Domestic Use

States	Percent of State Population
Arizona, Florida, Hawaii, Idaho, Mississippi, Nebraska, Nevada, New Mexico	Over 90
South Dakota	80 – 89
Delaware, Iowa, Maine	70 – 79
Alaska, Indiana, Kansas, South Carolina, Washington, Wisconsin, Utah	60 – 69
Arkansas, California, Illinois, Louisiana, Michigan, Montana, New Hampshire, North Dakota, Tennessee, Texas, Vermont, West Virginia, Wyoming	50 – 59
Georgia, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Virginia	40 – 49
Alabama, Connecticut, Massachusetts, Missouri, North Carolina, Oklahoma, Oregon	30 – 39
Colorado, Kentucky, Rhode Island	20 – 29
Maryland, Puerto Rico, Virgin Islands	Under 20

Note: For the purpose of this report, Puerto Rico and the Virgin Islands are treated as states in this table and all following tables. The information for these tables has been developed from Volume II of this report

Source: State Ground Water Program Summaries, Office of Ground Water Protection, EPA, March 1985

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

MAY 1[illegible]

Mr. Rick Hind
U.S. Public Interest Research Group
National Association of State PIRGs
215 Pennsylvania Ave., S.E.
Washington, D.C. 20003

Dear Mr. Hind:

Thank you for your letter of March 28, 1988, concerning the availability of data on detections of pesticides in ground water. We agree with you that the broad and timely access to such data is important to the development of sound ground water protection programs. Since the Environmental Protection Agency (EPA) receives such data from many sources and the contents of these reports may vary substantially, it is also important to assess the reliability of the data. In this case, it has taken the Agency a long time to assess these data, and I appreciate your bringing your concerns to my attention.

To make the data we have received to date available immediately and to prevent similar problems in the future, we have established a public docket for the ground-water monitoring reports which the Agency has received. The docket can be reviewed by the public in Room 246, Crystal Mall #2, 1921 Jefferson Davis Highway, Arlington, Virginia, during normal business hours. We will also be announcing the establishment of this docket widely so that all parties concerned about ground-water protection will be aware of its existence. Our plans are to update the docket periodically as we receive additional reports on ground-water monitoring findings.

We are also planning to complete a summary assessment of the data which will be available for public review by the end of this summer. In preparing the summary, we need to discuss both the accuracy of the information and the possible causes of positive findings with the investigators who conducted these monitoring studies. At the same time, we will be improving the efficiency of such reviews and, therefore, our timeliness in completing future summary assessments.

Generally, the monitoring reports have been provided by the States as a courtesy to EPA. These reports are derived from studies that can vary greatly in regard to purpose, protocol, and accuracy. Without further discussion with the States, it is difficult for the Agency to assess how representative a study's findings are of the general situation within a particular state. Without such an assessment, we would have little confidence in aggregating the findings of the different states to derive a summary picture of the national extent of ground-water contamination by pesticides. From a regulatory policy standpoint, it is also important to assess whether reported contamination is a result of normal use or a misuse of a product, a leak or spill at mixing/loading operations, or some situation completely unrelated to agriculture. As you are aware, we are also undertaking a national survey designed to provide a statistically-based picture of the extent and scope of the presence of pesticides in drinking water. The study's design is intended to avoid some of the limitations of the information described above.

Finally, you mention that several groups have submitted formal Freedom of Information Act (FOIA) requests for the ground-water monitoring reports. Our records show only one such request from Ms. Nancy Nickell of Renew America Project, and we are informing her of the availability of the public docket as well.

Again, thank you for bringing your concerns to my attention. I believe the public docket will significantly improve early availability of monitoring reports. It will allow the Agency the time necessary to complete the summary assessment and aggregation of findings without denying public access. If I may be of further service, please let me know.

Sincerely yours,

John A. Moore
Assistant Administrator
for Pesticides
and Toxic Substances

Pesticides Included in the EPA National Pesticide Survey

Acifluorfen*
Alachlor*
Aldicarb*
Aldicarb sulfone*
Aldicarb sulfoxide*
Aldrin
Ametryn*
Atraton
Atrazine*
Atrazine, dealkylated
Barban
Baygon*
Bentazon*
Bromacil*
Butachlor
Butylate*
Carbaryl*
Carbofuran*
Carbofuran phenol
Carbofuran phenol-3KET
Carbofuran-3OH
Carboxin*
Chloramben*
Chlordane-alpha*
Chlordane-gamma*
Chlorneb
Chlorobenzilate
Chlorothalonil*
Chlorpropham
Cyanazine*
Cycloate
2,4-D*
Dalapon*
2,4-DB
DBCP*
DCPA
DCPA diacid metabolite
4,4'-DDD
4,4'-DDE
4,4'-DDT
Demeton-S
Diazinon*
Dicamba*
3,5-Dichlorobenzoic acid
1,2-Dichloropropane*
cis-1,3-Dichloropropene*
trans-1,3-Dichloropropene*
Dichlorprop
Dichlorvos
Dieldrin*
Dinoseb*
Diphenamid*
Disulfoton*
Disulfoton sulfone
Disulfoton sulfoxide
Diuron*
EDB*
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin*
Endrin aldehyde
EPTC
Ethoprop
Etridiazole
ETU*
Fenamiphos*
Fenamiphos sulfone
Fenamiphos sulfoxide
Fenarimol
Fluometuron*
Fluridone
HCH-alpha
HCH-beta
HCH-delta
HCH-gamma
Heptachlor*
Heptachlor epoxide*
Hexachlorobenzene*
Hexazinone*
5-Hydroxy Dicamba
Linuron
Merphos
Methiocarb
Methomyl*
Methoxychlor*
Methyl paraoxon
Metolachlor*
Metribuzin*
Metribuzin DA
Metribuzin DADK
Metribuzin DK
Mevinphos
MGK 264
Molinate
Napropamide
Neburon
Nitrates/Nitrites*
4-Nitrophenol
Norflurazon
Oxamyl*
PCP
Pebulate
cis-Permethrin
trans-Permethrin
Picloram*
Prometon*
Prometryn
Pronamide*
Pronamide metabolite
Propachlor*
Propanil
Propazine*
Propham*
Simazine*
Simetryn
Stirofos
Swep
2,4,5-T*
Tebuthiuron*
Terbacil*
Terbufos*
Terbutryn
2,4,5-TP*
Triademefon
Tricyclazole
Trifluralin*
Vernolate

April 14,1988

* Priority pesticides which have a high potential for leaching into groundwater. For information on Health Advisories, contact the Safe Drinking Water Hotline, 1-800-426-4791, toll-free Mon-Fri 8:30-4:30 E.S.T. (In Washington, D.C., call 382-5533).

ATTACHMENT 1

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CA001	California Water Quality Control Board, "Control of Pesticide Discharges to North Coast Waters", North Coast Region, Nov. 21, 1984.
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HI001	Memorandum dated 5/20/87 to C. Jones, U.S. EPA from B. Kaneshiro, EPA Region IX.
HI002	Oki, D.S. and T.S. Giambelluca, "DBCP, EDB, and TCP Contamination of Ground Water in Hawaii", University of Hawaii, draft paper submitted to Journal of Contaminant Hydrology in February 1986.
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IA002	Libra, R.D., G.R. Hallberg, G.G. Ressmeyer, and B.E. Hoyer, "Groundwater Quality and Hydrogeology of Devonian-Carbonate Aquifers in Floyd and Mitchell Counties, Iowa", Iowa Geological Survey Open File Report 84-2, 1984.
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MD001	Pinto, E., "Report of Groundwater Contamination Study in Wicomico County, Maryland", prepared by Environmental Health Division, Wicomico County Health Deparment, June 1980.
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ME902	Inter-departmental memorandum dated 1/6/88 to State of Maine Pesticides Control Board from Henry Jennings, State of Maine Pesticides Control Board.
MI001	Letter dated 8/24/87 to R.F. Mountfort, U.S.EPA/OPP/RD from Karen Stumpf, CIBA-GEIGY Corporation, Agricultural Division.
MN001	Klaseus, T., "Minnesota Pesticide Monitoring Surveys Interim Report". Presented by Minnesota Dept. of Health and Minnesota Dept. of Agriculture, at "Pesticides and Groundwater: A Health Concern for the Midwest", sponsored by the Freshwater Foundation, U.S.

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WI003	Postle, J.K., "Ground Water Monitoring Project for Pesticides", a progress report submitted by the Department of Agriculture, Trade and Consumer Protection to the Department of Natural Resources, 1987.
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ATTACHMENT 1 (Cont)

PESTICIDES IN GROUND WATER DATA BASE
BIBLIOGRAPHICAL INFORMATION SHEET

Ref. Number	Full Reference
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CONCENTRATION OF PESTICIDES IN GROUND WATER Table 1

	AL	AR	CA	CO	CT	GA	FL	HI	IL
Alachlor	.	.	+	.	.	.	.	.	.02-.33
Aldicarb	.	.	44	.	.	.	.	.	+
Aldrin	.	.	.	.	.	.	.	.	+
Atratone	.	.	.	.	.	.	.	.	.
Atrazine	.	.	+	2.3	.	.	.	.05-4.1	.
Benzene	.	.	.	.	.	.	.	.	.
Benzene Hexachloride	.	.	.05	.	.	.	.	.	+
Bromocile	.	.	+	.	.	.	3-189	.	.
Butylate	.	.	.	.	.	.	.	.	.
Carbaryl	.	.	80	.	.	.	.	.	.
Carbofuran	.	.	5	.	.	.	.	.	.
Chloramben	.	.	.	.	.	.	.	.	.
Chlordane	.	.	.	.	.	.	.	.	+
Chloropyrifos	.	.	.	.	.	.	.	.	+
Chlorothalonil	.	.	.	.	.	.	.	.	.
Creosote	.	.	.	.	.	.	.	.	.
Cyanazine	.	.	.	.	.	.	.	.	+
1,2-Dichloropropane	.	.	.	.	290	.	.	.	.
1,3-Dichloropropene	.	.	.	.	+	.	.	.	.
2,4-D	.	.	.	.	.	.	.	.	.
Dacthal	.	.	.	.	.	.	.	.	.
Diazinon	.	.	.	.	.	.	.	.	+
Dibrom	.	.	.	.	.	.	.	.	.
Dibromochloropropane DBCP	.	.	+	.	.	.	.	+	.
Dicamba	.	.	.	.	.	.	.	.	.
Dieldrin	.	.	.	.	.	.	.	+	.08
Dimethoate	.	.	+	.	.	.	.	+	.
Dinoseb	.	.	.	.	.	.	.	.	.
Disyston	.	.	.	.	.	.	.	.	.
Diuron	.	.	+	.	.	.	.	.	.
Endosulfan	.	.	100	.	.	.	.	.	.
Endrin	.	.	.	.	.	.	.	.	.
Ethion	.	.	30	.	.	.	.	.	.004-.67
Ethoprop	.	.	.	.	.	.	.	.	.
Ethylene Dibromide EDB	.	.	140	.	.	+	+	.	.
Fonofos	.	.	.	.	.	.	.	.	.
Heptachlor	.	.	.	.	.	.	.	.	.025-.8
Heptachlor Epoxide	+	.	.	.	.	.	.	.	+
Hexazione	.	.	1.99	.	.	.	.	.05-.7	.
Lindane	.	.	46	.	.	.	+	+	+
Linuron	.	.	.	.	.	.	.	.	.
Malathion	.	.	23	.	.	.	.	.	.
Metalaxyl	.	.	.	.	.	.	.	.	.
Methomyl	.	.	.	.	.	.	.	.	.
Methylene Chloride	+	.	7	.	.	.	.	.	.
Metolachlor	.	6.7	.	.	.	.	.	.	.
Metribuzon	.	.	.	.	.	.	.	.	+
Molinate	.	.	+	.	.	.	.	.	.
Omite	.	.	92	.	.	.	.	.	.
Ordram	.	.	6.3	.	.	.	.	.	.
Oxamyl	.	.	.	.	.	.	.	.	.
Paraoxon	.	.	6	.	.	.	.	.	.
Paraquat	.	.	.	.	.	.	.	.	.
Parathion	.	.	4	.	.	.	.	.	.
PCP	.	.	.	.	.	.	.	.	.
Phorate	.	.	20	.	.	.	.	.	.
Phthalates	.	.	10	.	.	.	.	.	.
Picloram	.	.	.	.	.	.	.	.	.
Prometon	.	.	+	.	.	.	.	.	.
Propachlor	.	.	.	.	.	.	.	.	.22-2.0
Propazine	.	.	.	.	.	.	.	.	.
Silvex	.	.	1.0	.	.	.	.	.	.
Simazine	.	.	.53	.	.	.	+	.	1.07-7.3
TCP	.	.	980	.	.	.	.	.	.
Terbufos	.	.	.	.	.	.	.	.	.
Thiodan	.	.	.	.	.	.	.	.	.
Toxaphene	.	.	123	.	.	.	.	.	.
Tordon	.	.	.	.	.	.	.	.	.
Treflan	.	.	.9	.	.	.	.	.	.
Trichloromethane	.	.	.	.	.	.	.	.	.
Trichloropropane	.	.	.	.	.	.	.	2.0	.
Trifluralin	.	.	.	.	.	.	.	.	.011-.14
Zytron	.	.	30	.	.	.	.	.	.
TOTAL PESTICIDES	2	1	31	1	2	1	4	7	17

*** Numbers represent range of concentration or highest concentration (ppb-parts per billion). "+" indicates positive detection of unknown concentration.**

CONCENTRATION OF PESTICIDES IN GROUND WATER Table 2

	IA	KS	MA	MD	ME	MI	MN	MO	MS
Alachlor	16.6	.88	+	.1-.9	+	.	9.76	.	.
Aldicarb	.	.	30+	.	2-38	.	30.6	31	33-48
Aldrin	.	.	.	.	.	.	.	.	.
Atratone	.	1-129	.	+	.	.	.	.	.
Atrazine	10	.	.	.4-.9	+	1-210	42.4	.	.
Benzene	.	2.3	.	.	.	.	.	.	.
Benzene Hexachloride	.	.	.	.	.	.	.	.	4.2
Bromocile	.	.	.	.	.	.	.	.	.
Butylate	.	.	.	.	.	.	.	.	.
Carbaryl	.	.	.	.	.	.	.	.	.
Carbofuran	.6	+	.	.	.	.	.	.	.
Chloramben	.	.	.	.	.	.	.	.	.
Chlordane	1.8	.58	.	.	.	.	.	.	.
Chloropyrifos	.	.	.	.	.	.	.21	.	.
Chlorothalonil	.	.	.	.	.	.	.	.	.
Creosote	.	.	.	.	.	.	.	.	.
Cyanazine	80	.	.	.	.	.	.1	.	.
1,2-Dichloropropane	.	1.6	.03-51	2-440	.	.	.	.	.
1,3-Dichloropropene	.	.	+	.	.	.	.	.	.
2,4-D	.4	1.3	.	.	.	.	4.2	.	.
Dacthal	.	.	.	.	.	.	.	.	.
Diazinon	.	.	.	.	.	.	.	.	23
Dibrom	.	.	.	.	.	.	.	.	.
Dibromochloropropane DBCP	.	.	.	2-13	.	.	.	.	.
Dicamba	12	.	.	.	.	.	2.1	.	.
Dieldrin	.028	.	.	.	.	.	.	.	5.2
Dimethoate	.	.	.	.	.	.	.	.	.
Dinoseb	.	.	.36-36	.	+	.	.	.	.
Disyston	.	.	.	.	.	.	.	.	.
Diuron	.	.	.	.	.	.	.	.	.
Endosulfan	.	.	.	.	+	.	.	.	.
Endrin	.	.	.	.	.	.	.	.	.21-.3
Ethion	.	.	.	.	.	.	.	.	.
Ethoprop	.	.	.	.	.	.	.	.	.
Ethylene Dibromide EDB	.	.	+	.	.	.	.	.	.
Fenofos	.1	.	.	.	.	.	.	.	3.5-6.4
Heptachlor	.	.	.	.	.	.	.	.	.05-.14
Heptachlor Epoxide	.	.026	.	.	.	.	.	.	.
Hexazione	.	.	.	.	+	.	.	.	.
Lindane	.	.	.	.	.	.	.	.	.
Linuron	.	.	.	.	.	.	.	.	.
Malathion	.	.	.	.	.	.	.	.	5.2-8.4
Metalaxyl	.	.	.	.	.	.	.	.	.
Methomyl	.	.	.	.	.	.	.	.	.
Methylene Chloride	.	.	.	.	.	.	.	.	.
Metolachlor	.6	.	.	.	.	.	2.1	.	.
Metribuzon	4.4	.	.	.	+	.	.78	.	.
Molinate	.	.	.	.	.	.	.	.	.
Omite	.	.	.	.	.	.	.	.	.
Ordram	.	.	.	.	.	.	.	.	.
Oxamyl	.	.	+	.	.	.	.	.	.
Paraoxon	.	.	.	.	.	.	.	.	.
Paraquat	.	.	.	+	.	.	.	.	.
Parathion	.	.	.	.	.	.	.	.	.
PCP	.	.	.	.	.	.	.	.	45.7
Phorate	.	.	.	.	.	.	.	.	.
Phthalates	.	.	.	.	.	.	.	.	.
Picloram	.	.	.	.	.	.	.13	.	.
Prometon	.	.	.	.	.	.	.	.	.
Propachlor	.	.	.	.	.	.	.52	.	.
Propazine	.	.	.	.	.	.	.	.	.
Silvex	.	.	.	.	.	.	.26	.	.
Simazine	.	.	.	.1	.	1-16	2.58	.	.
TCP	.	.	.	.	.	.	.	.	.
Terbufos	.	.	.	.	.	.	.63	.	.
Thiodan	.	.	.	+	.	.	.	.	.
Tordon	.	5.6	.	.	.	.	.	.	.
Toxaphene	.	.	.	.	.	.	.	.	.
Treflan	.	.	.	.1	.	.	.	.	1.8
Trichloromethane	.	.6	.	.	.	.	.	.	.
Trichloropropane	.	.	.	.	.	.	.	.	.
Trifluralin	.	.	.	.	.	.	.	.	.
Zytron	.	.	.	.	.	.	.	.	.
TOTAL PESTICIDES	11	9	8	8	8	2	14	1	10

*** Numbers represent range of concentration or highest** concentration (ppb-parts per billion).
"+" indicates positive detection of unknown concentration.

CONCENTRATION OF PESTICIDES IN GROUND WATER — Table 3

	MT	NC	ND	NE	NJ	NY	OR	PA	RI
Alachlor	.	.	.	.	.	.	.	3.4	.
Aldicarb	1.5	2-28.2	.	.	3.1-50	515	.	.	150
Aldrin	.	.	.	.	.	.	.	.	.
Atratone	.	.	.	.1	.	.	.	.	.
Atrazine	.	.	.	.	.	.	.	.40-40	.
Benzene	.	.	.	.	.	.	.	.	.
Benzene Hexachloride	.	.	.	.	.	.	.	.	.
Bromocile	+	.	.	.	.	.	.	.	.
Butylate	.	.	.	.	.	.	.	.	.
Carbaryl	.	.	.	.	.	+	.	.	1
Carbofuran	.	.	.	.	.	65	.	.	4
Chloramben	.	.	.	.	.	.	.	.	.
Chlordane	.	.	.	.	.	.	.	.	.
Chloropyrifos	.	.	.	.	.	.	.	.	.
Chlorothalonil	+	.	.	.	.	16.3	.	.	.
Creosote	+	.	.	.	.	.	.	.	.
Cyanazine	.	.	.	.	.	.	.	.	.
1,2-Dichloropropane	.	.	.	.	.	300	.	.	.
1,3-Dichloropropene	.	.	.	.	.	.	.	.	.
2,4-D	+	.	.	.	.	.	.	.	.
Dacthal	.	.	.	.	.	1036	11-290	.	.
Diazinon	.	.	.	.	.	.	.	.	.
Dibrom	.	.	.	.	.	+	.	.	.
Dibromochloropropane DBCP	.	.	.	.	.	+	.	.	.
Dicamba	3.0	.	.	.	.	.	.	.	.
Dieldrin	.	.	.	.	.	.	.	.	.
Dimethoate	.	.	.	.	.	.	.	.	.
Dinoseb	.	.	.	.	.	4.5	.	.	.
Disyston	.	.	.	.	.	.	.	.	.
Diuron	.	.	.	.	.	.	.	.	.
Endosulfan	.	.	.	.	.	.	.	.	.
Endrin	+	.	.	.	.	.	.	.	.
Ethion	.	.	.	.	.	.	.	.	.
Ethoprop	.	.	.	.	.	+	.	.	.
Ethylene Dibromide EDB	.	.	.	.	.	.	.	.	.
Fonofos	.	.	.	.	.	.	.	.	.
Heptachlor	.	.	.	.	.	.	.	.	.
Heptachlor Epoxide	.	.	.	.	.	.	.	.	.
Hexazione	.	.	.	.	.	.	.	.	.
Lindane	.	.	.	.	.	.	.	.	.
Linuron	.	.	.	.	.	.	.	.	.
Malathion	.	.	.	.	.	.	.	.	.
Metalaxyl	.	.27-1.4		.	.	.	.	.	.
Methomyl	.	.	.	.	.	+	.	.	.
Methylene Chloride	.	.	.	.	.	.	.	.	.
Metolachlor	.	.	.	.	.	.	.	.05-3.0	.
Metribuzon	.	.	.	.	.	.	.	.	.
Molinate	.	.	.	.	.	.	.	.	2
Omite	.	.	.	.	.	.	.	.	.
Ordram	.	.	.	.	.	.	.	.	.
Oxamyl	.	.	.	.	.	18	.	.	.
Paraoxon	.	.	.	.	.	.	.	.	.
Paraquat	.	.	.	.	.	+	.	.	.
Parathion	.	.	+	.	.	.	.	.	.
PCP	+	.	.	.	.	.	.	.	.
Phorate	.	.	.	.	.	.	.	.	.
Phthalates	16	.	.	.	.	.	.	.	.
Picloram	.	.	.2-12.	.	.	+	.	.	.
Prometon	.	.	.	.	.	.	.	.	.
Propachlor	.	.	.	.	.	.	.	.	.
Propazine	.	.	.	.1	.	.	.	.	.
Silvex	.	.	.	.	.	.	.	.	.
Simazine	.	.	.	.	.	.	.	.2-3.0	.
TCP	.	.	.	.	.	.	.	.	.
Terbufos	.	.	.	.	.	.	.	.	.
Thiodan	.	.	.	.	.	.	.	.	.
Tordon	.	.	.	.	.	.	.	.	.
Toxaphene	.	.	.	.	.	.	.	.	.
Treflan	.	.	.	.	.	.	.	.	.
Trichloromethane	.	.	.	.	.	.	.	.	.
Trichloropropane	.	.	.	.	.	.	.	.	.
Trifluralin	.	.	+	.	.	.	.	.	.
Zytron	.	.	.	.	.	.	.	.	.
TOTAL PESTICIDES	8	2	3	2	1	14	1	4	4

*** Numbers represent range of concentration or highest** concentration **(ppb-parts per billion).**
"+" indicates positive detection of unknown concentration.

CONCENTRATION OF PESTICIDES IN GROUND WATER Table 4

	SC	SD	TX	VA	VT	WA	WI
Alachlor	.	.16-6.7	.	.	.	.	1-7
Aldicarb	.	.	2-6	1-8	.	.	200
Aldrin	44.8	.	.	.	.	.	.
Atratone	.	.	.	.	.	.	1-33
Atrazine	.	.36-7.1	.	.	1-2	.	+
Benzene	.	.	.	.	.	.	.
Benzene Hexachloride	.	.	.	.	.	.	.
Bromocile	.	.	.	.	.	.	.
Butylate	.	.	.	.	.	.	+
Carbaryl	.	.	.	.	.	.	.
Carbofuran	.	.	.	.	.	.	.
Chloramben	.	.	.	.	.	.	+
Chlordane	.	.	.	.	.	.	.
Chloropyrifos	.	.	.	.	.	.	.
Chlorothalonil	.	.	.	.	.	.	.
Creosote	.	.	.	.	.	.	.
Cyanazine	.	.	.	.	1-2	.	.
1,2-Dichloropropane	.	.	.	.	.	.	.
1,3-Dichloropropene	.	.	.	.	.	.	.
2,4-D	.	.29-.8	.	.	.	.	.
Dacthal	.	.	.	.	.	.	.
Diazinon	.	.	.	.	.	.	.
Dibrom	.	.	.	.	.	.	.
Dibromochloropropane DBCP	.	.	.	.	.	.	.
Dicamba	.	.	.	.	.	.	.
Dieldrin	.	.	.	.	.	.	.
Dimethoate	.	.	.	.	.	.	.
Dinoseb	.	.	.	.	.	.	+
Disyston	.	.	.	.	.	.	+
Diuron	.	.	.	.	.	.	.
Endosulfan	.	.	.	.	.	.	.
Endrin	.	.	.	.	.	.	.
Ethion	.	.	.	.	.	.	.
Ethoprop	.	.	.	.	.	.	.
Ethylene Dibromide EDB	.	.	.	.	.	.018-5	+
Fonofos	.	.	.	.	.	.	.
Heptachlor	.	.	.	.	.	.	.
Heptachlor Epoxide	.	.	.	.	.	.	.
Hexazion	.	.	.	.	.	.	.
Lindane	21.1	.	.	.	.	.	.
Linuron	.	.	.	.	.	.	1.3-2.7
Malathion	.	.	.	.	.	.	.
Metalaxyl	.	.	.	.	.	.	.
Methomyl	.	.	.	.	.	.	.
Methylene Chloride	.	.	.	.	.	.	.
Metolachlor	.	.	.	.	1-2	.	.8-12
Metribuzon	.	.	.	.	.	.	.08-6.8
Molinate	.	.	.	.	.	.	.
Omite	.	.	.	.	.	.	.
Ordram	.	.	.	.	.	.	.
Oxamyl	.	.	.	.	.	.	.
Paraoxon	.	.	.	.	.	.	.
Paraquat	.	.	.	.	.	.	.
Parathion	.	.	.	.	.	.	.
PCP	.	.	.	.	.	.	.
Phorate	.	.	.	.	.	.	.
Phthalates	.	.	.	.	.	.	.
Picloram	.	.	.	.	.	.	.25-4.9
Prometon	.	.	.	.	.	.	.
Propachlor	.	.	.	.	.	.	.
Propazine	.	.	.	.	.	.	.
Silvex	.	.	.	.	.	.	.
Simazine	.	.	.	.	.	.	.
TCP	.	.	.	.	.	.	.
Terbufos	.	.	.	.	.	.	.
Thiodan	.	.	.	.	.	.	.
Tordon	.	.	.	.	.	.	.
Toxaphene	.	.	.	.	.	.	.
Treflan	.	.	.	.	.	.	.
Trichloromethane	.	.	.	.	.	.	.
Trichloropropane	.	.	.	.	.	.	.
Trifluralin	.	.	.	.	.	.	.
Zytron	.	.	.	.	.	.	.
TOTAL PESTICIDES	2	3	1	1	3	1	13

* Numbers represent range of concentration or highest concentration (ppb-parts per billion).
"+" indicates positive detection of unknown concentration.

Table 5

Pesticide	Health Effects
Alachlor	oncogen*
Aldicarb	vomiting stomach pain blurred vision weakness
Aldrin	damages reproductive system possible carcinogen
Atratone	vomiting stomach pain respiratory irritation depression
Atrazine	damages central nervous system (CNS) possible carcinogen
Benzene	teratogen, mutagen, possible carcinogen
Benzene Hexachloride	damages CNS possible carcinogen effects fertility
Bromocile	male reproductive system damage possible carcinogen
Butylate	alters testicles birth defects possible carcinogen
Carbaryl	vomiting stomach pain blurred vision weakness
Carbofuran	vomiting stomach pain blurred vision weakness
Chloramben	damages liver birth defects
Chlordane	damages CNS damages liver probable carcinogen
Chloropyrifos	mutagen* teratogen* damages CNS
Chlorothalonil	decreased birth weight kidney damage probable carcinogen
Creasote	oncogen mutagen
Cyanazine	causes miscarriage teratogen
1,2-Dichloropropane	damages liver and kidney probable carcinogen
1,3-Dichloropropene	oncogen
2,4-D	affects brain teratogen mutagen possible carcinogen
Dacthal	damages liver
Diazinon	vomiting stomach pain blurred vision weakness
Dibrom	
Dibromochloropropane DBCP	oncogen mutagen affects reproduction probable carcinogen
Dicamba	hyperactivity muscular spasms teratogen
Dieldrin	causes miscarriage teratogen probable carcinogen
Dimethoate	
Dinoseb	affects reproductive system teratogen
Disyston	vomiting blurred vision stomach pain weakness
Diuron	teratogen
Endosulfan	damages CNS
Endrin	oncogen teratogen damages CNS
Ethion	teratogen mutagen damages CNS
Ethoprop	teratogen mutagen damages CNS
Ethylene Dibromide EDB	oncogen mutagen affects repro.system probable carcinogen
Fonofos	vomiting stomach pain blurred vision weakness
Heptachlor	possible mutagen possible carcinogen
Heptachlor Epoxide	possible carcinogen
Hexazione	damages liver and blood
Lindane	oncogen teratogen reproductive effects
Linuron	mutagen damages bone marrow probable carcinogen
Malathion	mutogen terotogen damages CNS
Metalxyl	conjunctivitis
Methomyl	damages liver kidney spleen and bone marrow
Methylene Chloride	mutagen teratogen possible carcinogen
Metolachlor	vomiting damages testicles possible carcinogen
Metribuzon	damages liver and kidney possible carcinogen
Molinate	vomiting possible paralysis teratogen
Omite	
Ordram	
Oxamyl	damages kidneys affects respiration blurred vision vomiting
Paraoxon	damages kidneys and lungs
Paraquat	damages kidneys and lungs decreases birth weight
Parathion	mutagen carcinogen
PCP	damages kidneys and liver
Phorate	mutagen teratogen damages CNS
Phthalates	
Picloram	damages liver affects fertility teratogen
Prometon	damages kidneys
Propachlor	damages liver and kidneys causes miscarriage
Propazine	delays fetal bone development possible carcinogen
Silvex	oncogen teratogen fetotoxin* damages liver and kidneys
Simazine	tremors paralysis possible carcinogen
TCP	oncogen fetotoxin
Terbufos	vomiting stomach pain blurred vision weakness
Thiodan	damages repro.system teratogen possible carcinogen
Tordon	
Toxaphene	possible carcinogen
Treflan	
Trichloromethane	vomiting blurred vision stomach pain weakness
Trichloropropane	
Trifluralin	oncogen mutagen possible carcinogen
Zytron	

*Important Terms:

fetotoxin--substance that is fatally toxic to fetus
mutagen--substance that causes genetic changes in subsequent generations
oncogen--substance that causes tumors
teratogen--substance that causes birth defects
carcinogen--substance that causes cancer

TESTIMONY OF

DR. JACK D. EARLY, PRESIDENT

NATIONAL AGRICULTURAL CHEMICALS ASSOCIATION*

Before the
United States House of Representatives
Committee on Public Works and Transportation
Subcommittee on Investigations and Oversight

August 11, 1988

Mr. Chairman, I wish to thank you and the Subcommittee for the opportunity to participate in this hearing on pesticides in ground water.

I understand that the purpose of this hearing is to explore the general subject of pesticides in ground water and what the agricultural pesticide industry is and should be doing to learn about and prevent contamination. You have probably heard already about the value of ground water, the lack of complete information about whether and how much it may be contaminated from many sources, and the important differences in the relative roles of federal and state government authorities. Accordingly, I will not take much time on those issues here.

Let me turn first to our efforts to learn about the potential of pesticides entering ground water.

Our efforts begin before a product is sold. As you may know, federal registration for pesticides involves the development and submission of exhaustive information about the product, including data on hydrolysis, photolysis in soil and water, aerobic and anaerobic effects and other information on environmental fate. For older products, where EPA believes further information is needed, we also must supply this data on EPA's request. EPA has already required environmental fate data for approximately 140 widely used active ingredients. We estimate that this is well over 80% of all of the pesticides applied to agricultural land in the United States.

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* Dr. Early is accompanied by Dr. George R. Oliver, Research Leader, North American Agricultural Products Department, The Dow Chemical Company, and Dr. George L. Rolofson, Manager of Government Relations, Agricultural Division, CIBA-GEIGY Corporation.

Companies in our industry are also monitoring for residues in ground water as part of product stewardship. These companies recognize that it is in their interest, in order to continue marketing products responsibly, to know in advance about potential adverse effects. Many of these companies are engaged in costly and extensive monitoring programs. For example, in recent testimony before a House Agriculture Subcommittee, Monsanto estimated that it had spent over $11 million on water quality research from 1985 to present.

Along with various federal and state agencies, we are also conducting extensive research on the conditions for products leaching into ground water. This is an effort to collect physical, chemical, and biological data and other information that may indicate the potential for products to leach, as well as developing models and statistical analyses for prediction. Our expert witnesses accompanying me today are prepared to discuss these efforts if you would like amplification. It is sufficient to say now that this prediction methodology is a vital element in effective monitoring programs.

An important aspect of this information-gathering effort is in relating actual pesticide usage, environmental and other conditions to positive and negative findings of pesticides in ground water. Our experience has been so far that there are surprising inconsistencies and unknowns in this kind of information. This is true especially with point source contamination from spills, well back-flows, drainage wells, poorly constructed wells, and sink-holes--distinguished from non-point source contamination from pesticide applications. The weakness of some monitoring programs to date is that they fail to consider agricultural practice, soil and weather conditions, and actual water and pesticide use. Without sufficient investigation, background and coordination, improper conclusions may be drawn about the real causes and significance of ground water contamination.

Turning now to my second major theme: As we learn more about the potential for pesticides in ground water, our industry is also developing strategies on minimizing the entry of pesticides into ground water.

We are proud of our record in educating our customers on responsible pesticide use and the ways to avoid having agrichemicals get into ground water. You may already know of the NACA booklet entitled, "Protecting Our Groundwater." It was jointly developed by NACA, USDA, American Farm Bureau Federation, and National Agricultural Aviation Association, and is already into its third printing, with over 200,000 copies distributed. The corn and soybean growers, in cooperation with one of our companies, have distributed over 2,000 copies of a film on agrichemicals and ground water protection. Agricultural extension services, local agrichemical distributors, and our field sales forces have also produced additional hands-on ground water advice.

For several years, NACA has actively worked with EPA, and federal and state Agricultural Extension Service personnel to encourage applicators and agricultural producers to attend state-sponsored certification training programs. These programs are designed not only to improve grower understanding of ground water issues, but also to provide practices and procedures to reduce potential ground water contamination from agricultural chemicals. We believe that these state-sponsored certification training programs are key to ground water education.

Also, with the objective of providing a benchmark for assessing the impact of pesticides in ground water, NACA urged EPA to develop and publish "health advisories." This was a critical first step in EPA's large-scale ground water study, now underway. These numbers, developed on the basis of extensive toxicity data already in the Agency's files and to which is added a several-fold safety factor, provide both useful public information about the health significance of pesticides that may be found and a trigger for regulatory efforts.

Finally, with respect to our efforts to reduce any potential for harmful contamination of ground water, we are trying to develop new products, formulations, and applications. There are many examples:

- Materials that have less persistence and biodegrade rapidly in the soil.
- Products with higher biological activity, allowing use rates to be reduced from pounds to ounces per acre.
- More effective post-emergence herbicides that significantly reduce soil contact.
- Improved targeting of products to the pest by application techniques, such as electronic spray devices.
- Formulations that are easier to clean-up if spilled.

Again, public and private efforts in determining the cause of ground water contamination are key to developing new products and application techniques. The federal government's research efforts on ground water are, thus, a critical part in our mutual efforts in helping to preserve a reliable and abundant food supply. Although much research has already been done in this area, further research should focus on:

- Developing and validating ground water and surface water computer modeling techniques.
- Mapping aquifers; determining aquifer quality and present and future aquifer uses.
- Studying degradation and mobility of pesticides in subsoils and in saturated zones.
- Developing best management practices, taking into account application rates, timing and frequency to reduce leaching potential and ground water concentrations.

In closing I would like to touch briefly on pending ground water legislation before Congress. Our industry supports initiatives in addressing ground water research issues. Better coordination of federal ground water research activities is constructive and needed. We also support the provisions in S.1516 and H.R.2463 dealing with the regulation of pesticides in ground water, as reported by the Senate Agriculture Committee and House DORFA Subcommittee. The bills responsibly recognize our nation's dual needs for safe and abundant water and food. S.1516 and H.R.2463 are, in large part, the result of a cooperative effort over several years by a coalition of over 40 environmental groups, agricultural interests, EPA, Congress, and the agrichemical industry.

Again, Mr. Chairman, I wish to thank you and members of this Subcommittee for the opportunity to speak on our efforts to prevent pesticides in ground water. I would like to reserve an opportunity to amplify my remarks and written testimony. My associates and I will be happy to try to answer any questions that you may have.

11.29

NATIONAL
FARMERS
UNION

TESTIMONY OF

THE HONORABLE STEVEN MORSE

SENATE OF MINNESOTA

on behalf of

THE NATIONAL FARMERS UNION

before

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
U.S. HOUSE OF REPRESENTATIVES

August 11, 1988

Good morning Chairman Oberstar and other members of the Committee, and thank you for the opportunity to be here. I am Steve Morris, an apple farmer from Minnesota and a member of the State Senate. I am here this morning on behalf of the National Farmers Union to discuss the state of our groundwater resources in Minnesota, how my farmer neighbors and constituents are feeling, and what our state is doing to preserve this precious resource for the future.

As a delegate to the last Minnesota Farmers Union convention, I was able to visit with farmers from all over the State on issues such as groundwater. I assure you, Mr. Chairman, they and other NFU members all over the country are concerned about the environmental impact of their farming and ranching operations. The organization's 1988 policy statement relating to groundwater concerns is attached to my testimony.

In speaking to farmers about chemical use and groundwater, the same questions keep coming up. Farmers in drought areas are concerned about lasting damage to their soils not just from a productivity standpoint, but also because the agricultural chemicals already applied to the land have not been activated in many areas. With many of these chemicals still near the surface, a substantial rainfall will carry them with the runoff into water supplies. Farmers want to know what's in the water their families and livestock are drinking, what will happen to their property values if their water is contaminated, whether they will have to stop using a pesticide because it has been found in wells elsewhere in the country, and whether there really is an alternative to pesticide use, when government agencies and their bankers have been telling them for years that increased yields are needed.

Many farmers' and citizens' concerns can be addressed, depending on how -- or if -- the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) is reauthorized by the 100th Congress. NFU has strongly supported passage of a FIFRA bill this year, particularly if we can speed up the process of reregistering older pesticides to get better information. Armed with the facts, we can develop a national plan to prevent groundwater contamination, clean it up where it has occurred already, and hopefully remove some of the greatest offenders from the market. The agricultural community should play an active role in developing and implementing that plan.

Let me touch briefly on several areas which we believe should be a part of any Congressional effort to address growing concerns in groundwater protection. First, we believe that farmers and their agency, the U.S. Department of Agriculture (USDA), must acknowledge agriculture's contribution to groundwater problems and take an active role in the solutions that will benefit all citizens. I am not suggesting that the Secretary of Agriculture supplant the Administrator of the Environmental Protection Agency (EPA) in handling FIFRA or that USDA should take the lead role from the Occupational Safety and Health Administration (OSHA) in handling matters pertaining to farmworker safety. We are suggesting that USDA should be a source of information; to EPA in terms of normal farming practices and the needs of the industry, and to farmers in terms of the latest information on environmental dangers and how to minimize them. We would encourage coordination between EPA and USDA to the maximum extent possible. USDA agencies, such as the Soil Conservation Service and the Extension Service, provide service to farmers on an individual basis, and are a trusted source of information. Farmers should be involved at the state and local level to help plan and implement groundwater protection measures that meet environmental concerns in a responsible fashion without placing an unreasonable burden on their operations. Farmers must also be involved in efforts to deal with contamination that has already occurred. Government rules and regulations are much easier for farmers to accept when they have been part of a cooperative process to develop workable programs. This has been borne out in other environmental programs, for example my state's Reinvest in Minnesota program and the Chesapeake Bay clean-up effort underway in Mr. Clinger's home state of Pennsylvania.

The second item which must be present in a national effort at groundwater protection is adequate program funding. If states are to become the eyes, ears, and fists of the EPA; if conservation district directors and cooperative extension service agents are to fulfill their roles, then we must stand ready to make the necessary financial commitment. A thorough program without funding or staff is of little use to anyone at any level.

Third, NFU feels that we could make broader use of the conservation programs already available, particularly the Conservation Reserve Program (CRP), in developing a coordinated national approach to groundwater protection and clean-up. The Great Plains Conservation Program, Agricultural Conservation Program, Rural Clean Water Program, Water Bank, and most recently, CRP, have proven their worth in achieving land use adjustment and conservation of our land and water resources. Many of these tools could be adapted easily to situations where the environmental threat is from pesticides or fertilizers rather than wind or water erosion.

Why not expand CRP to accommodate land that should not be farmed due to a variety of environmental considerations? The program has worked to idle thousands of acres of highly erodible land in many states. Why not include land with a soil type highly vulnerable to pesticide leaching? Why not include land with sinkholes in the middle of a field? The program already contains safeguards for local input suppliers by limiting total county acreage in the program to twenty-five percent. The program is already familiar to farmers and USDA. The program generates some return on a farmer's land -- for which he pays property taxes whether he farms it or not.

Fourth, and finally, Mr. Chairman, a serious effort at reducing groundwater contamination must include research and education on less chemically-intensive farming methods. Fertilizers and pesticides represent a significant share of a farmer's input costs, and we have only begun to understand the environmental costs of how America produces its food. NFU strongly believes that government research agencies, such as the Agricultural Research Service, should consider methods of sustainable agriculture to be as important a research priority as methods of increasing production -- which often require greater use of chemicals. We are concerned that much of the current research on the use of agricultural chemicals is done by the companies who develop them in the course of obtaining a FIFRA registration. While improving technology will help the chemical industry to provide safer chemicals for our food production, we should strengthen efforts to teach farmers how to farm with fewer chemicals.

Thank you for the chance to be here today. I would be happy to answer any questions you might have.

From the National Farmers Union's 1988 Policy and By-Laws

Article 1, Section I, Paragraph 8

8. Pesticide and Herbicide Regulation

The Environmental Protection Agency is far behind schedule in reviewing, testing and registering the 600 major ingredients in the 50,000 commercial pesticides now on the commercial market.

Information on the comparative risk involved in using certain pesticides and chemicals must be available so that farmers, who have the most exposure to the products, can balance the benefits against the risks.

Most important, reauthorization of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) should include a provision absolving farmers of liability for damages as long as they use pesticides according to label directions.

We are disappointed at the year-by-year failure of the Congress to extend and perfect the FIFRA law.

Until biological controls or other effective alternatives to pesticides are available, we call for cooperation among farmers, chemical companies, and governmental agencies to reduce pollution hazards.

Chemical manufacturers are partly responsible for the problems arising from container disposal and should increase use of reusable and bulk chemical containers. Federal assistance is needed in recycling containers and in establishing central locations for disposal of chemical containers.

Farmers must be involved in solving these problems so that solutions that are unacceptable to farmers are not forced upon us.

Article 6, Section E

E. The Environment

We recognize the need for enormous amounts of energy in all forms. We believe this energy should be generated without polluting the earth, air, and water. Pollution standards should be set at levels to prevent damage to health, crops, and livestock. Energy-producing corporations must be required to meet those standards.

We urge enactment of legislation, both federal and state, providing authority by the Environmental Protection Agency (EPA) to prohibit dumping of hazardous and toxic wastes in the United States without detoxification. We also encourage development of hazardous waste disposal methods, other than landfills, with stricter enforcement of laws on transporting and handling hazardous waste.

We, the delegates, direct the National Farmers Union to appoint a Groundwater Contamination Task Force.

The future of agriculture producers worldwide depends to a great extent on addressing the obvious problem of the proper use of pesticides and chemical fertilizers.

National Farmers Union should take leadership in developing policy that will work toward preventing chemical contamination of groundwater and, at the same time, not be prohibitive to profitable agriculture.

The National Farmers Union is further directed to immediately motivate state and local groups to institute programs for the accumulation and proper disposal of excess and outdated agricultural chemicals in containers sitting around the farms and agri-businesses of most communities.

Our groundwater must be safeguarded from contamination. We oppose the method of deep well injection of dangerous chemicals and hazardous waste because of the risk of contaminating our water sources.

SUNDAY, AUGUST 7, 1988

From the Fargo Forum, Fargo, N.D.

Erosion doubles drought's impact

By William Robbins
NEW YORK TIMES

LINTON, N.D. — The dismay still clouded Mark Jahner's face as the young farmer looked out over a field he had hoped to see covered with wheat.

Now there was nothing there except barren subsoil. The rich topsoil had dried up and blown away, leaving yet another scar from the drought of 1988.

"The dust clouds were so dark you could see them 10 miles away," Jahner said. "But there wasn't a thing I could do to save the land. There was nothing I could do except stand there and watch it go."

The 25-year-old farmer is one of thousands across the Middle West who have suffered doubly from this year's drought, both in crop losses and in damage to the land itself.

The damage from wind erosion this year has been exceeded in the Great Plains only three times since 1935, when the Agriculture Department first started keeping records of erosion in the 10-state region.

Now, soil conservationists say, the farmers face still greater damage in a lack of plant growth and crop stubble to hold dusty topsoils in place.

Furthermore, they say, the dusty land is now so unstable that the first heavy rains can wash the topsoil away by the hundreds of tons, severely reducing the fertility of the land that is left. And the soil blown or washed away by wind and water erosion causes still greater damage in the places where it finally comes to rest — in rivers and lakes that provide both drinking water and recreation as well as in ditches and on roads,

☐Farmers
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☐Farmers

Continued from Page A1

from which it must be removed.

"Our first concern is that soil cover is going to be minimal this coming fall and winter because of the drought," said Gerald Root, deputy director of conservation planning in the Agriculture Department's Soil Conservation Service. "The less cover you have from grass and crops the more damage you're going to get from wind and water.

"Our second concern," he continued, is that agricultural chemicals — the pesticides, herbicides and fertilizers — have not been activated by growth and water in wide areas. That will affect not only what can be planted next year, it will affect the cover that will be available to protect the soil.

"Now, most of those chemicals are at or near the surface," he said. "If we get a return to normal or excessive rains, we will also be facing risks of greater problems from the runoff, with those chemicals getting into water supplies, impairing the quality of drinking water and resources for recreation, for fishing and swimming."

Here in south-central North Dakota, Jahner's loss was a personal one. He had returned from a job in Nevada to take over operation of his family's farm from a tenant, only to see the top five inches of one of his best fields, nearly 40 acres of good North Dakota soil, blow away in those black clouds.

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STATEMENT OF THE AMERICAN FARM BUREAU FEDERATION TO THE HOUSE COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT WITH REGARD TO GROUNDWATER PROTECTION

Presented by Mark A. Maslyn
Assistant Director, National Affairs Division

August 11, 1988

STATEMENT OF THE AMERICAN FARM BUREAU FEDERATION TO THE HOUSE COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT WITH REGARD TO GROUNDWATER PROTECTION

August 11, 1988

The American Farm Bureau Federation is a general farm organization with over 3.5 million member families in 49 states and Puerto Rico. Our members produce nearly every kind of crop or commodity grown and harvested commercially in the United States.

Recently the Senate Committee on Agriculture, Nutrition and Forestry and the House Agriculture Subcommittee on Department Operations, Research and Foreign Agriculture reported legislation to reauthorize the Federal Insecticide, Fungicide and Rodenticide Act, generally known as FIFRA.

Included in both bills, S. 1516 and H.R. 2463, are provisions of interest to this Committee dealing with groundwater protection and liability.

With regard to the issue of pesticides in groundwater, we believe it is appropriate for FIFRA to address this issue and to establish a process to respond to the problem. Groundwater is very important to agriculture. Over 90 percent of our rural population relies on groundwater as a source of drinking water, and the potential for pesticide contamination is a matter of great concern and discussion within agriculture. While farmers and ranchers agree that we need to protect this resource, there is also a concern that any such effort must recognize the vital role that agricultural chemicals play in modern farming. Farmers and ranchers would prefer not to have to use agricultural chemicals to control weeds, disease and pests, but circumstances dictate otherwise. Until alternative methods of crop protection are commercially practical and until biotechnology products are available, we must be careful not to overreact so that the cure becomes worse that the problem.

Another reason that we must be cautious in our response to pesticides in groundwater is because of our limited knowledge of the scope, as well as the causes and effects of the problem. Contrary to growing public perception, most pesticides do not leach. Furthermore, there appears to be increasing evidence that the causes of the problem is generally not the routine field application, but rather a point-source factor such as shallow wells, unique soil characteristics, improperly cased or cracked wells, or mixing and loading too close to wells.

This all underscores the need for increased information, education and research. This Committee has spent considerable time preparing legislation addressing the research and information component to the problem. Farm Bureau supports and encourages those efforts and has spent considerable effort in similar education, training and water testing programs among our members. In addition, the EPA nationwide pesticides in groundwater survey, which is just beginning, should yield valuable information on the extent of the problem. So we believe that while it is important to respond to this issue, federal policy must be reasonable and in proportion to our knowledge and understanding of the problem.

One major area of debate has been the definition of the resource that we are protecting. We believe that the definition of underground sources of drinking water should distinguish between different types of groundwater, different uses and other factors such as depth, quality and quantity. It is important to allow for flexibility in responding to contamination problems and in establishing priorities for different types of groundwater.

Another important issue in the groundwater debate has been the standard of protection. Ideally, groundwater would be without contaminants, and standards would not be necessary. We all recognize however, that there are a number of human activities benefiting society that do impact our environment and thus make standards necessary. We need to set standards that are reasonable and practical but also protective of public health. We have supported the use of the Maximum Contaminant Level (MCL) as the standard of protection for both public and private wells. In the case of carcinogens, we favor a negligible risk standard. We believe that is is not only unnecessary but also would be counter productive to establish a set of standards protecting rural groundwater that is more stringent that those used for public water systems. It would result in confusion and overproduction, and also erode public confidence in the safety of their water supply. We believe that the use of the MCL goal as a standard is inappropriate.

Still another important element in any federal groundwater policy should be a recognition that states have primary responsibility in protecting this site specific and soil specific resource. It is inherently a state issue, and the federal government should not attempt to establish priorities or mandate performance for the states. EPA's primary responsibility should be the establishment of standards and, relating to the subject of pesticide contamination, focus on the authority to register, review and cancel pesticides that pose unacceptable risks.

We also believe that any federal groundwater legislation should directly involve the Department of Agriculture in a full and substantive way. The Soil Conservation Service (SCS), the Agricultural Stabilization and Conservation Service (ASCS), the Agricultural Research Service (ARS), the Cooperative State Research Service (CSRS), and the Extension Service all have outstanding technical, scientific, data collection and outreach capability that should be utilized. In short, they have the site specific and soil specific knowledge necessary to make sound decisions. In our opinion, most bills are deficient in this regard.

Directly related to the issue of groundwater protection is that of liability. For some time, we have been seeking a clarification of federal law that establishes the notion that a farmer who has followed federally established pesticide use instructions and not acted negligently or recklessly should not be strictly liable for environmental pollution. We recognize that although no attempt has been made under federal law to hold a farmer strictly liable for groundwater contamination, there have been instances at the state level. While we do not seek to preempt state law, clarification by the Congress of federal environmental statutes would likely be interpreted as a strong signal of congressional intent. Furthermore, it would remove the uncertainty and implicit contradiction in federal law.

We want to reiterate our support for efforts to protect groundwater from pesticide contamination. No other segment of society has more at stake in this issue than the farmer who depends on wells for drinking and agricultural chemicals to protect his crop investment. Farm Bureau has made extensive efforts to train, inform and educate our members about groundwater protection. We have developed an environmental checklist to be used on farms and ranches, and we have an ongoing well-testing program that has enabled thousands of farmers across the country to test for contaminants. We are actively encouraging every County Farm Bureau to adopt and promote this well testing program.

Additional examples of some other activities include the following:

* Seven County Farm Bureaus in Indiana offered nitrate testing of water well samples at their county fairs in the summer of 1987. Indiana Farm Bureau also participated with the Purdue Agronomy Department in a sampling program at the Agronomy Farm Field Day. None of the samples tested exceeded nitrate health standards.

* Pennsylvania Farmers Association (Farm Bureau) tested nitrates for several thousand farmers at the statewide Ag Progress Days, as part of the ongoing county Farm Bureau program.

* North Dakota Farm Bureau is working with their state Health Department to test well water for nitrates at NDFB's statewide annual meeting.

* Massachusetts, Maryland, Minnesota and New Hampshire Farm Bureaus are planning to use Farm Bureau's Groundwater and Environmental Pollution Self-Help Checklist at their annual meeting workshops.

* Ohio Farm Bureau has been part of a cooperative nitrate testing program with Heidelberg College and other groups. As of October 22, 1987, 25 counties participated and 5,000 wells were tested, Ninety-seven (97) percent of the samples were less than 10 ppm. Eighty (80) percent showed no contamination at all.

In addition, the Ohio Farm Bureau, Soil and Water Conservation Service, Extension and EPA are working jointly to promote a conservation tillage program with Ohio farmers. The group is interested in developing economic incentives to encourage farmers to adopt conservation tillage practices.

* In February, 1986, the American Farm Bureau Federation conducted an educational water testing program at its annual Program Kickoff Meeting. Samples were received and analyzed for pesticides and nitrates from 44 states.

* Oregon Farm Bureau helped initiate a voluntary disposal program for empty pesticide containers in conjunction with the Oregon Agricultural Chemicals Association. The pilot program in 1984 involved one site and collected 8,000 containers. In 1986, the program involved 15 sites and collected 20,000 cans.

* Massachusetts Farm Bureau has been instrumental in getting several departments of the state government to work together on, and the state legislature to fund, a demonstration program for composting manure. This stabilizes nutrients and reduces odor.

* New York, Connecticut and Massachusetts Farm Bureaus have been active in seeking state support of IPM studies.

* AFBF initiated its own Conservation Tillage Action Plan in 1983. It is designed to encourage state and county Farm Bureaus to take a more active role in promoting conservation tillage. County Farm Bureaus in South Carolina, Tennessee and Indiana contributed funds or time to set up demonstration and equipment rental programs where none existed.

* Over 1,000 copies of AFBF's booklet, "Farm Partners, Have You Hugged Your Soil Lately?," have been distributed. Also, over 40 sets of a slide show illustrating the program have been distributed. The material takes a systems approach to soil compaction, erosion and protective soil cover. The workshop includes actual field experience and stresses cooperation with local extension and soil and water experts.

* North Carolina, South Carolina and Virginia Farm Bureaus have initiated and helped pass state laws allowing tax credits for farmers who purchase conservation tillage equipment.

For your review, I have provided a copy of the program manual to your staff, and have attached copies of two publications we have developed for our members to my complete statement.

We believe there are clear and important roles for the state and federal government, and especially the private sector to play in protecting groundwater. Above all, however, federal policy on this issue should be protective yet practical and reasonable.

We look forward to working with you and your staff to constructively address areas of mutual concern. Thank you.

Attachments

STATEMENT OF DIANE BAXTER
BEFORE
THE SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION

AUGUST 11, 1988

Mr. Chairman, my name is Diane Baxter. I am staff scientist at the National Coalition Against the Misuse of Pesticides (NCAMP), a non-profit, public interest group which works to inform the public about the properties of chemical pesticides and the availability of alternatives to their use. I hold a Masters degree in Environmental Toxicology, and have been at NCAMP for three years, analyzing the potential hazards of chemical pesticides on man and the environment.

NCAMP fully supports Rep. Oberstar's bill H.R. 3174, because we believe it contains all the elements necessary for successful protection of our nation's precious groundwater resources. We are encouraged that this bill relies on health-based standards for pollution control, and sets up a regulatory trigger mechanism to mobilize regulatory efforts to control contamination before maximum limits are exceeded. This makes good sense because groundwater pollution is a "pay me now or pay me later" situation. It is far more expensive to clean-up than to prevent damage, not just in terms of property damage, but especially in terms of health consequences.

I am not here today to talk about political strategy, but rather to address a single substantive issue. NCAMP believes that there is great need to consider carefully whether the institution of health based standards ought not be the essential core, and not a negotiable issue, in all environmental or public health legislation. It is NCAMP's position that health-based standards are the key to public health protection, in every area, and that no pesticide legislation should be supported that lacks at least the elements of H.R. 3174. Any pesticide legislation that fails to address groundwater can only be thought of as a "stop-gap" measure. Any groundwater legislation that codifies unprotective standards is unprotective of public health from the outset.

While H.R. 3174 is an example of the kind of legislation that the citizens of this country need, many proposals floating around Capitol Hill are suggesting that the public accept a new "negligible risk" standard of protection. This is inappropriate for several reasons.

Problems defining risk

In spite of what you hear, we still do not do a very good job of calculating risks to human health, in fact we consistently underestimate them because it is easier to. First, such a process depends heavily on the collection and the analysis of a great deal of data, data that we still do not have in our possession. The level of compliance with statutory requirements is still too low. Secondly, the scope of the data we collect for risk assessment is still too limited. For example, although Congress has formally recognized that data requirements to assess potential neurotoxicity of pesticides are in need of a drastic overhaul, we still do not have the necessary data requirements in place. We still do not require data that would assess the potential for immunotoxicity. Therefore, we still lack the ability to define risk with any precision.

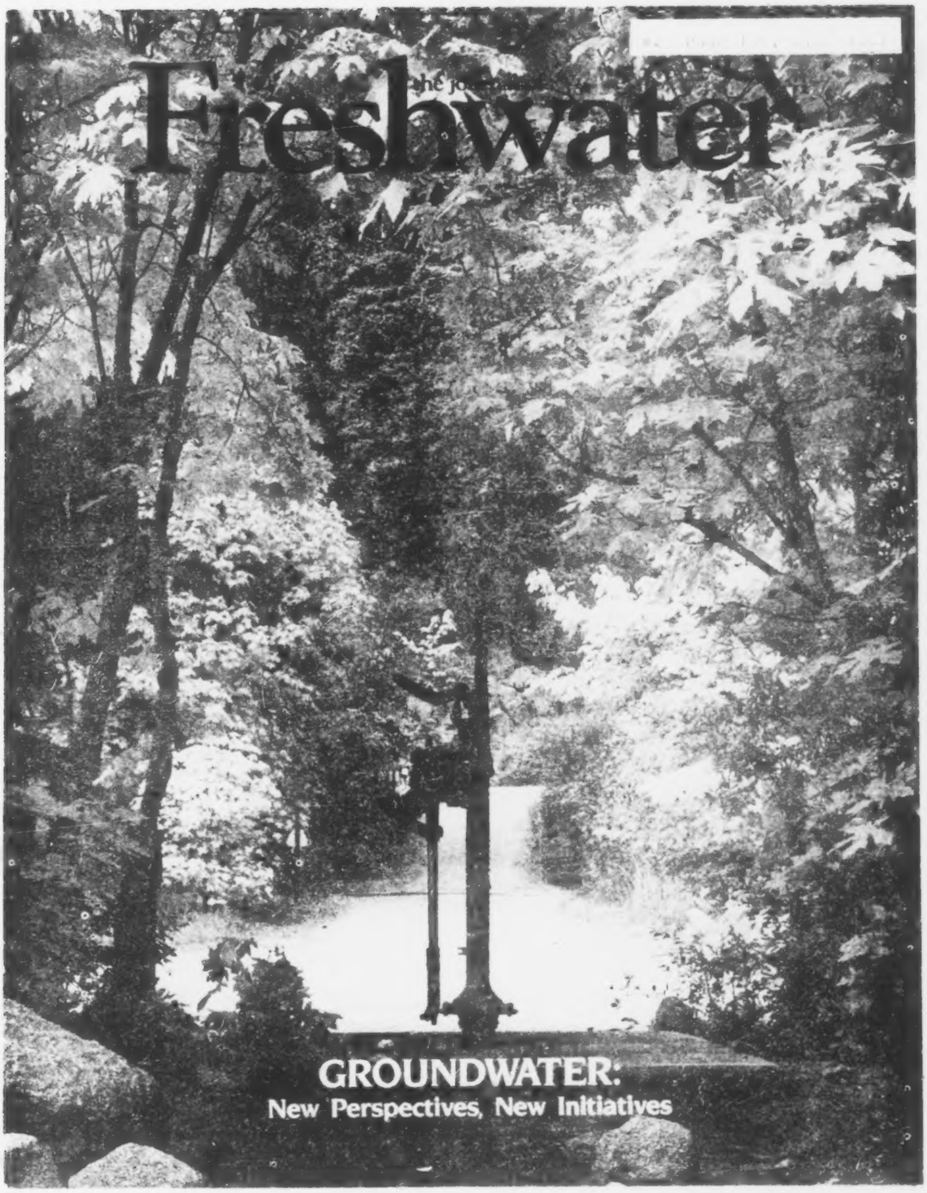
Problems defining exposure.

The "negligible risk" concept being promoted adds up to an unacceptable risk when all pesticide exposures are aggregated, even more so when exposure to other non-pesticide chemical contaminants are factored into the equation. Under a "negligible risk" standard, we pretend that a population is exposed to one active ingredient at a time when regulating risk, ignoring the possible contribution of "inert" ingredients, as well as the likelihood that other chemicals are part of the total exposure picture at any given time. EPA identified no less than 55 carcinogenic agricultural chemicals in current use on food crops. Fortunately, such artificial reasoning has been rejected in H.R. 3174.

Determining benefits of use.

If as a society, we are prepared to accept all sorts of poorly defined risks, then the regulators, manufacturers, and users must be prepared to rigorously define the supposed benefits of pesticide use. In particular, they should be prepared to look at the benefits of all non-chemical alternatives available, and show why assumption of increased risks should be considered beneficial to society. Pesticides are not just another commercial product, they are manufactured with the intent of poisoning part of the ecosystem. Rarely, indeed, has there been any commitment among users or manufacturers to explore what alternatives to the use of pesticides exist, before these products are used, nor has there been a concerted effort among regulators to consider alternatives in advance of registration. Under the current Federal Fungicide, Insecticide, Fungicide, and Rodenticide Act (FIFRA), efficacy data is not even required. Negligible risk standards do nothing to encourage the adoption of least-toxic food production practices that are protective of the environment.

In conclusion, NCAMP hopes that our comments on this very important piece of legislation can help to create a record rebutting arguments that "negligible risk" standards are protective of public health.



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Freshwater

GROUNDWATER:

New Perspectives, New Initiatives

the journal of Freshwater

Comment by the Editor

This year's *Journal*, "Groundwater: New Perspectives, New Initiatives," provides a four-part overview of groundwater, an unseen but increasingly critical national resource.

Part I defines groundwater and explains how it functions as a major component of the hydrologic cycle.

Part II explores the extent of this country's growing reliance on groundwater.

Part III describes a few of the ways in which both groundwater quantity and quality are affected by society's actions.

Part IV presents a number of innovative efforts taking place to protect groundwater supplies.

New perspectives are developing. New initiatives are being undertaken by federal agencies, by states and cities, and by the private sector. This year's *Journal* should help to demonstrate why groundwater is fast becoming the resource issue of the decade.

Linda Schroeder

Linda Schroeder

Freshwater Foundation
2500 Shadywood Road, Box 90, Navarre, Minnesota, U.S.A. 55392
(612) 471-8407

The Freshwater Foundation is a nonprofit corporation which built and equipped the Gray Freshwater Biological Institute, an international research center devoted to the multi-disciplinary study of the complex problems of freshwater. In 1976, the Institute was donated to the University of Minnesota. The Foundation continues to fund and support research as well as national and international information/education programs.

The Freshwater Foundation translates and interprets freshwater issues and their implications for the public through conferences, publications, and television and radio programs on all aspects of freshwater issues.

Freshwater Friends is an international membership organization which supports both freshwater research and public information programs of the Freshwater Foundation.

The Journal of Freshwater Volume Nine, 1985
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Vice President for Education, Freshwater Foundation

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Perspective

For more than eight years the Freshwater Foundation has been developing programs and publications to increase public understanding of the importance of water resources to our lives and lifestyles.

Our perceptions of a resource determine how we use or abuse that resource. Nowhere have our perceptions been in greater need of change than in the area of groundwater.

Hidden beneath the earth's surface, this unseen resource provides 97 percent of the drinking water for rural Americans, 40 percent of all water for irrigation and 26 percent of all water used by industry. 50 percent of the United States population relies on groundwater for drinking water.

Growing awareness of the importance of groundwater to the viability of American cities, industries and agriculture, along with alarm over its declining quality and quantity, have focused national attention on this resource. The Environmental Protection Agency has developed the Office of Groundwater Protection to assist states in building the institutional capabilities they need to protect their groundwater.

The Office of Technology Assessment has issued a report calling for a national groundwater policy which has led to much congressional debate. The National Water Alliance and The Conservation Foundation have developed national groundwater task forces.

For the first time, the United States Geological Survey has included a state-by-state survey of groundwater resources in its *National Water Summary* 1984, and it will include a state-by-state assessment of groundwater quality in its 1986 water summary.

A total of 35 states have reported declining groundwater levels as a result of irrigation, with levels falling most dramatically in Arizona, Kansas, New Mexico and Texas.

Although hidden from sight, groundwater isn't hidden from sources of contamination. Pesticides have been found in groundwater in 25 states. There are somewhere between 1.4 and 2.5 million underground storage tanks across the nation, and 30 to 40 percent are thought to be leaking. 34 states have serious groundwater contamination from hazardous materials. Even local community landfills have proven to contain quantities of hazardous materials which have leached into residential wells.

Sooner or later, water becomes the ultimate repository of all substances released into the environment. Once contaminated, groundwater may remain so for hundreds or even thousands of years. Lack of sunlight, oxygen and significant water movement inhibits the process of degradation, and contaminants may remain unchanged for generations, rendering a groundwater supply unsafe as a source of drinking water.

The quality and quantity of America's groundwater resources are directly dependent on the effective management of wastes and withdrawals. Innovative waste disposal practices, public education and coordinated management of surface water and groundwater are all key factors in protecting and maintaining groundwater as a viable national resource.

As more groundwater is lost to contamination and overdrafting, competition for available supplies will increase. This competition will stress the limited financial resources of states as they weigh the various needs of wastewater systems, water delivery systems, groundwater recharge or reclamation, and other infrastructure needs.

It is hoped that the background information on groundwater use and the examples of innovative groundwater management efforts highlighted in this *Journal* will offer ideas and encouragement to all levels of the public and private sectors involved in water resource management.

Christine Olsenius

Christine Olsenius
Vice President for Education
Freshwater Foundation

Water flowing from an artesian well in Door County, Wisconsin
Photo by Ken Bradbury

"Out of Sight, Out of Mind": Understanding Groundwater

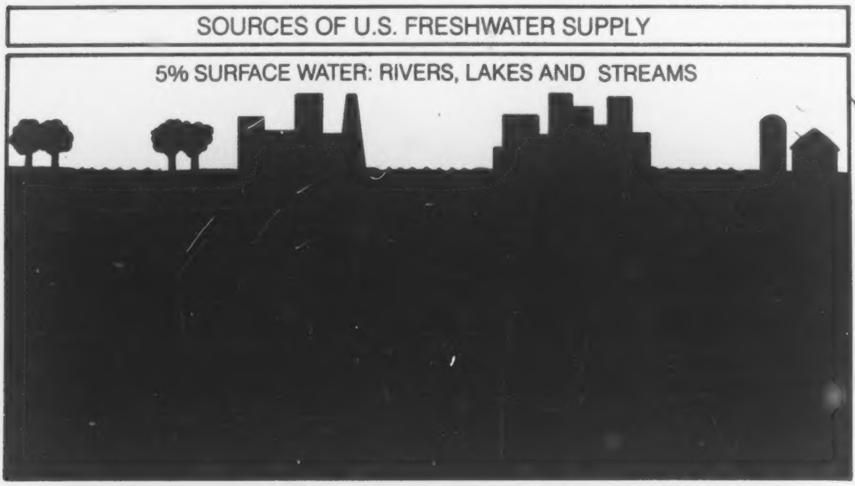

SOURCES OF U.S. FRESHWATER SUPPLY
5% SURFACE WATER: RIVERS, LAKES AND STREAMS

Illustration by Joleen Ross

Half of us drink it, 97 percent of rural communities depend on it—and no one really knows much about it. The process of developing a better understanding of groundwater should begin with a look at the basics of what groundwater is and how it works.

Picture all the water in all the rivers, lakes and streams throughout the country—the entire surface supply of freshwater in the United States.

Now try to imagine **20 times** that much water stored all over the United States—out of sight, but much of it available for use.

This vast "hidden supply" of water is groundwater. Only 5 percent of this nation's freshwater supplies are in our rivers, lakes and streams; the other 95 percent of our freshwater is groundwater.

Do we need groundwater?

Our lives depend on groundwater. Irrigated agriculture—and thus our food supplies—depend on it. Industry depends on it. 97 percent of all rural domestic supplies are groundwater. And more than half of the population of the United States depends on groundwater for its drinking water.

Groundwater may be an unseen resource, but it is becoming an increasingly critical and vulnerable resource. Its future is uncertain—and that uncertainty will surely affect our future as well. Addressing those uncertainties might best begin with a basic understanding of this vast hidden supply of water so important to our lives and lifestyles.

What is groundwater?

Groundwater is water stored underground, beneath the earth's surface. It is stored in cracks and crevices of rocks and in the pores of geologic materials that make up the earth's crust.

How much groundwater is there?

Underground, within one-half mile of the earth's surface, somewhere between 30 and 60 quadrillion gallons of usable freshwater are stored.

How much is 30-60 quadrillion gallons of water? It's 20 times the volume of all the surface water in the United States. It's the amount of water the Mississippi has discharged into the Gulf of Mexico during the last 200 years. It is 95 percent of this country's supply of freshwater.

Where does groundwater come from?

Groundwater originates as precipitation—rain or snow falling onto the surface of the earth.

Not all rain or snowmelt, however, becomes groundwater. Some of it evaporates back into the atmosphere. Some of it becomes runoff, replenishing rivers, lakes, streams and oceans. That portion of rain and snowmelt that does not evaporate or become runoff soaks into the ground, trickling down through the soil.

As it moves down through the soil, some of the water is retained near the surface in the **unsaturated zone**, in which the spaces between soil particles and the pore spaces in rock are filled with either water or air. Some of the water in the unsaturated zone is taken up by plants (in the transpiration process) and returned to the atmosphere. That water not retained in the unsaturated zone continues percolating downward. It passes across the water table into the **saturated zone**, in which all the porous spaces are filled—saturated—with water. The **water table** separates the unsaturated zone from the saturated zone, and water stored in the saturated zone is called **groundwater**.

Under what conditions does groundwater provide a usable supply of water?

Whether a particular area of groundwater will provide a supply of water depends on two properties of the particular geologic materials of that area: their **porosity** (ability to store water) and their **permeability** (ability to transmit water). The greater the porosity and permeability, the better the area as a usable source of water.

An underground, saturated, permeable geologic formation capable of producing significant quantities of water to a well or spring is called an **aquifer**. An aquifer is an identified, usable, significant source of groundwater.

How large are aquifers?

Aquifers vary tremendously in size. They may be anywhere from a few feet to hundreds of feet thick. They may be found just beneath the surface or hundreds of feet deep. They may lie under a few acres or thousands of square miles. The largest aquifer in the United States is the Ogallala Aquifer, which covers a 156,000-square-mile area.

Once used, how is a groundwater supply replenished?

Groundwater is a major feature of the hydrologic cycle, which is the circulating system for all the earth's water. This cycle is in constant operation, moving water from the earth to the atmosphere by evaporation and back again to the earth's surface as precipitation, to produce streamflow and groundwater flow.

Recharge (or infiltration) is the process by which water percolates from the earth's surface down through the soil to become groundwater. Recharge typically occurs in upland areas, with the groundwater then moving to lowland areas where it is discharged into wetlands, streams, lakes or springs.

This movement of groundwater is usually very slow, at a rate varying from a few inches per day to a few feet per year. Once it appears above ground (as in a spring), groundwater can evaporate back into the atmosphere, and the cycle begins again.

Can a groundwater supply be overused?

Yes. When the amount of water withdrawn from an aquifer is replenished or recharged with an equal amount of water, balanced use is occurring, and the average water level of the aquifer remains relatively constant.

Drawdown of an aquifer is a decline in the water level due to excessive groundwater withdrawals. **Overdraft** (or groundwater mining) is a continued decline in water level due to long-term withdrawal in excess of recharge. In 1975, 25 percent of all groundwater pumping was estimated to be overdrafting renewable supplies. Both local and regional overdrafts continue to occur in many areas of the country.

How does groundwater become contaminated?

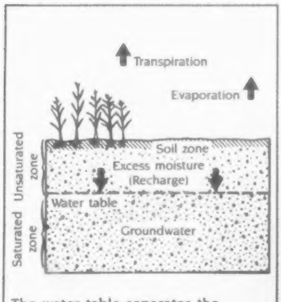
Contamination is the presence of undesirable substances in air, soil or water. As water moves through the hydrologic cycle, its quality is affected by both natural processes and the actions of humans.

In the air, its quality is influenced by the materials which cause air pollution. As the water precipitates, the chemicals which cause air pollution fall to earth with the water in the form of rain or snow.

On the ground, runoff picks up soil and carries with it such substances as animal waste, pesticides and fertilizers. As the water seeps down to the water table, it can also become contaminated by waste materials on the land or buried in landfills. Once contaminated, a groundwater supply may remain so for hundreds or even thousands of years.

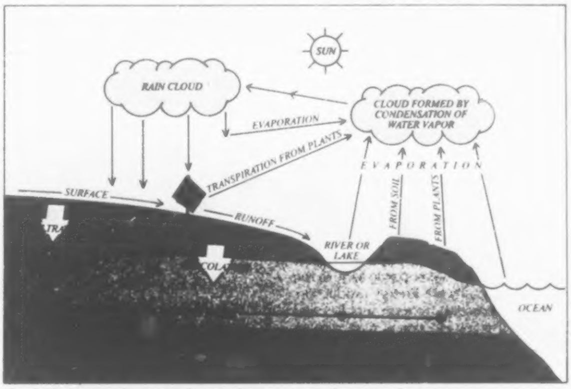
Groundwater: A Vast—and Vulnerable—Resource

It may be difficult to comprehend that 30-60 quadrillion gallons of **anything** could be considered "vulnerable," but usable, available groundwater supplies throughout this country are being adversely affected by overdrafting and contamination. Such effects on the availability of a resource so widely used for agriculture, industry and public drinking water supplies can also be expected to have a profound impact on the lives and lifestyles of all Americans.



The water table separates the unsaturated zone from the saturated zone (groundwater).

U.S. Geological Survey



The hydrologic cycle: Groundwater plays an integral part in the continuous evaporation-transpiration-precipitation process. Reprinted courtesy of High Plains Underground Water Conservation District No. 1

Growing Reliance on an Unseen Resource

by Linda Bruemmer

We drink it, we irrigate with it, we use it for industry and for domestic supplies across the country: We depend on groundwater. These many uses of groundwater affect its quantity and quality—and therefore directly affect our lives and lifestyles as well.

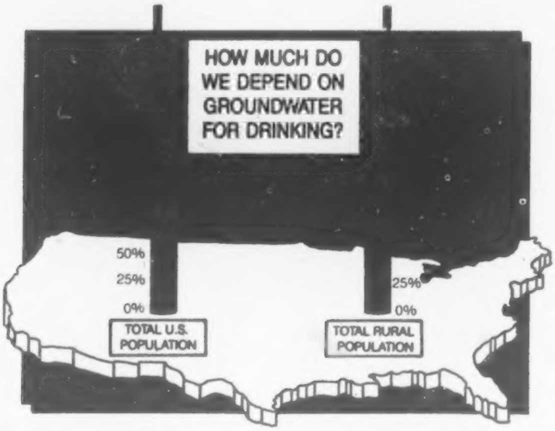


Illustration by Joleen Ross

Trends in Groundwater Use

Groundwater is increasingly being recognized as an important source of freshwater. At the same time, groundwater use as a supply of freshwater has also been increasing. During the last 25 years, total withdrawals of freshwater (both surface water and groundwater) have increased at an annual rate of 2 percent, while withdrawals of groundwater have increased at nearly double that rate—an average of 3.8 percent each year. A 300 percent increase in total withdrawals of groundwater has occurred in the last 35 years.

Increased groundwater use is reflected in growing water supply requirements for expanding urban areas, particularly in the South and Southwest. Energy production, drought protection back-up supplies and objections to construction of surface reservoirs also account for increased groundwater use. Furthermore, the pressures of population growth, increased per capita use, and contamination of surface water supplies are necessitating a greater dependence on groundwater.

Water for Drinking

More than 50 percent of the United States population relies on groundwater for its drinking water supplies. Groundwater is the major drinking water source for 32 states.

It is estimated that about 30 percent of the urban population relies on groundwater for drinking. For rural population, the dependence on groundwater is much greater: 97 percent of the rural population uses groundwater for drinking.

Water for Municipalities

Municipal water supply includes urban domestic and commercial use as well as some industrial use. Urban domestic use includes drinking, cooking, washing and sanitary needs, plus delivery losses, fire protection, street washing, and city and park maintenance.

Approximately 80 percent of municipal systems in the country rely on groundwater to serve the domestic needs of about 30 percent of the U.S. population. Of the 100 largest U.S. cities, 34 rely completely or in part on groundwater for their water supplies.

Water for Rural Use

Although per capita domestic use in rural areas is lower than in urban areas, dependence on groundwater is significantly higher. Rural domestic uses depend on groundwater for 97 percent of the rural population. For rural livestock needs, 55 percent of water used is groundwater.

Water for Industry

Industry throughout the country depends on groundwater for 26 percent of its water supply. Industrial water users include factories, plants and mills engaged in mechanical or chemical transformation of materials, components or substances into new products.

Water for Irrigation

The largest use of groundwater is for irrigation. Irrigated agriculture accounts for over 25 percent of the value of all crops produced in the United States on 12 percent of the cropland. 40 percent of this irrigation water is supplied by groundwater.

Use of groundwater for irrigation nationwide has increased 300 percent in 30 years.

"Biting the Hand That Feeds Us"

Many types of human activities can disrupt the natural equilibrium of an aquifer, affecting both the quality and quantity of the groundwater.

Regionally significant depletion of groundwater supplies has occurred in three major areas: southern Arizona, the High Plains and California. This depletion represents an absolute decline in the amount of the resource available.

At the same time, increased competition for developed supplies is taking place. Groundwater availablility issues are cited as concerns in 47 states.

Adequate supplies are one groundwater-related concern; a second concern focuses on the quality of groundwater supplies. Groundwater contamination problems exist in 40 states, according to a 1981 study.

Groundwater is a critical national resource for drinking, for domestic use, for industry and for irrigation. As the demand for available—and usable—supplies grows, it becomes increasingly essential to understand how groundwater is being affected and how adequate supplies can be maintained.

Linda Bruemmer is senior hydrologist for the environmental division of the Minnesota State Planning Agency.

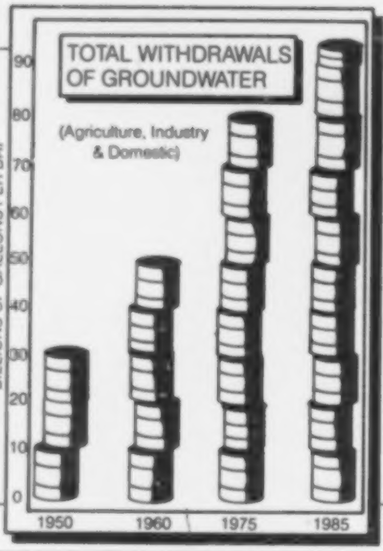


Illustration by [illegible] Ross

Turkey, Stuffing, Pumpkin Pie—and Lots and Lots of Water

A Thanksgiving dinner. A 20-pound turkey, stuffing, mashed potatoes, scalloped corn, pumpkin pie—and 42, 674 gallons of water.

A holiday dinner is a prime example of the large volumes of water needed to produce the food we eat. Food production uses vast amounts of water—for irrigating beans and corn as well as for growing feed for turkeys and grain for bread.

It takes 120 gallons of water to produce one egg, 300 gallons of water to "grow" a loaf of bread. A hamburger, fries and a cola use 1500 gallons of water through the various stages of production. And a holiday dinner for eight represents a use of 42,674 gallons of water—enough to completely fill a 30 x 50-foot swimming pool.

Here are the basic components of this "42,000-gallon holiday dinner."

Item	Gallons of water needed
20-pound turkey	16,300
Stuffing	6,004
Potatoes	72
Scalloped corn	1,824
Green beans	1,000
Carrots	1,000
Waldorf salad	580
Fresh fruit salad	2,000
Bread	300
Margarine (incl. cooking)	2,212
Pumpkin pie	1,240
Ice cream	1,142
Milk for four	1,000
Wine for four	8,000
	42,674 gallons of water

It takes 4000 gallons of water to produce the food for an average daily 2000-calorie diet—about two gallons of water per calorie. It may not be long before the concept of "counting gallons" becomes as important to all of us as that of counting calories.

Groundwater by the Six-Pack

A cold beer is part of the good life for a great many people. In fact, Americans drink 183.7 million barrels each year. One barrel contains 31 gallons—or 500 glasses—of beer.

To quench the thirst of that vast beer-drinking market, American breweries produce 196 million barrels of beer each year; another 6.3 million barrels are imported.

Competition to market the "beer of choice" leads brewers to spend millions of dollars on advertising. Although good buddies, good times and good taste are all common themes to advertise beer, one theme seems to appear repeatedly, year after year: good water. For many brewers that good water is groundwater.

In most areas, groundwater is a more consistent source of pure water than is surface water. The Jacob Schmidt Brewing Company of St. Paul, Minnesota, is a division of the G. Heileman Brewing Company, Inc., of LaCrosse, Wisconsin. Approximately 10 barrels of potable water are used in the production of each barrel of Schmidt beer. The company currently brews two million barrels of beer each year.

Each can of Schmidt beer carries this pledge: "We certify that Schmidt Beer is Brewed with the Purest Spring Water from the Northwest's Deepest Brewery Well." According to Wayne Ruppel, director of Corporate Quality Assurance for Heileman, that well is over 1000 feet deep and designed to ensure maximum protection from surface contamination. Nevertheless, he explains, water must be monitored periodically to measure pH and mineral content and to ensure purity.

According to Ruppel, contaminated wells are often shallow and lacking in sophisticated mechanisms to protect against surface contamination. If contaminants were to be found in a well, the cost in time and money to clean up the source, purge the well or, if all else failed, dig a new, deeper well or find another source of pure water would mean greater operating costs for the brewer and possibly higher prices for the customer.

When the gang at the neighborhood bar hoists its beer glasses high, a pledge to help keep groundwater pure might be a most appropriate toast. After all, if the supply of potable groundwater should be depleted or polluted, "here's mud in your eye" might take on an entirely new meaning.

Losing Ground to Land Subsidence

by Gail Dishongh

Sinkholes in Florida, floods in Houston, cars and trailers disappearing into the ground. All are specific examples of a widespread and growing concern: subsidence. This sinking of the earth's surface dramatically portrays the effects of overdrafting groundwater.

- New Orleans has sunk 2½ feet over a a 93-square-mile area.
- In California's San Joaquin Valley, the land surface has sunk as much as 29 feet.
- The west side of Houston is sinking by approximately 1 foot every 5 years.
- Between 1952 and 1977, a 120-square-mile area between Phoenix and Tucson sank more than 7 feet.

What is the cause of these substantial drops in land surface? The "culprit" is subsidence.

Understanding Subsidence

Subsidence is a gradual settling of the earth's surface. Related in part to the geologic properties of certain aquifers, subsidence can be greatly accelerated by heavy groundwater withdrawals.

When groundwater is removed from pores or openings in the aquifer material at a substantially faster rate than it is replaced, a decline in water pressure allows these "empty" openings to compact and settle, and subsidence occurs. Subsidence may appear as an overall sinking of the earth's surface, or it may result in the formation of large fissures, or cracks, in the land surface.

A Texas Story

Houston, the fourth largest city in the United States, boasts a population of nearly two million people—a 400 percent increase since 1940. The site of the third largest port in the United States, the Houston Ship Channel, this area provides easy access to the Gulf of Mexico.

This Gulf Coast area, made up of the counties of Harris and Galveston, exemplifies the problems related to land subsidence. The "sinking" of the coastal area, as well as inland parts within the two counties, has been attributed to the ever-increasing pumping of groundwater.

The average cost of groundwater per 1000 gallons in Houston is $1.00. As industry and population have grown, a cheap and easily accessible source of water has continued to supply the area's increasing water demands. Through time, land subsidence has been recorded—as much as 9½ feet along the Houston Ship Channel. Over a 1720-square-mile area, in the greater Houston area, the entire land

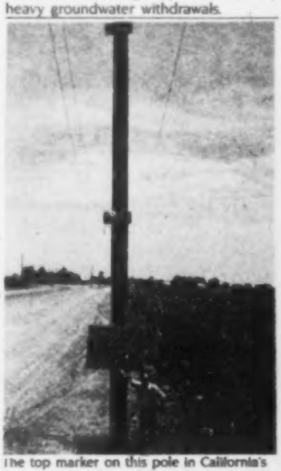


Photo courtesy of U.S. Geological Survey

The top marker on this pole in California's San Joaquin Valley indicates the level of the land surface in 1925. The additional markers show a drop of 29 feet in land surface from 1925 to 1977. This land subsidence was caused by groundwater overdrafting.

Photo courtesy of Harris-Galveston Coastal Subsidence District

This home in a residential subdivision of Baytown, Texas (near Houston), was stranded by a 1979 flood. The risk of such floods is increased significantly by land subsidence.

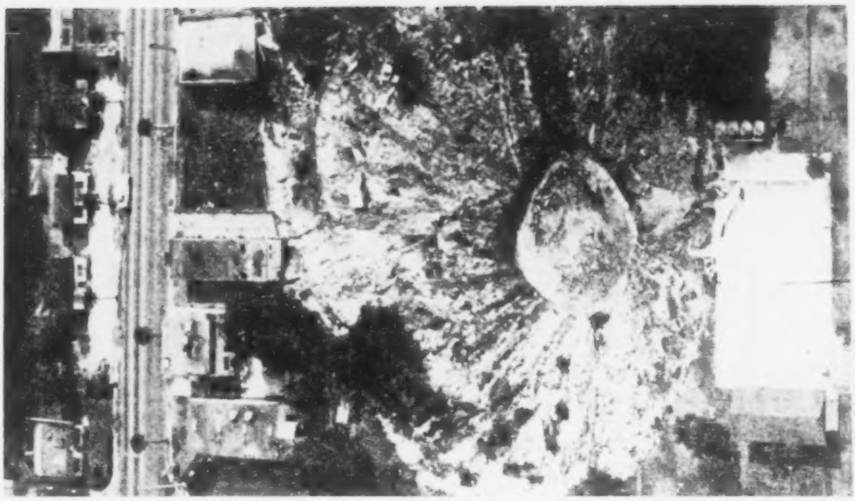


Photo by *The Orlando Sentinel*

This sinkhole in Winter Park, Florida, was the result of the 1981 collapsing of underground limestone caverns caused by groundwater overdrafts. The 125-foot-deep, 400-foot-wide chasm consumed one house, six Porsches, one camper, a sycamore tree, the back end of a few businesses, and a chunk of an Olympic-sized swimming pool.

surface has dropped by 12 inches (one of the largest "sinkholes" in the United States). It is estimated that the southwest section of Harris County, the large growth center of Houston, is sinking at a rate of about 1 foot every 5 years.

How Subsidence Happens

The Houston-Galveston area rests on two major aquifers, the Chicot and the Evangeline. Both are made up of sand (porous and permeable) and clay (a nearly impermeable material). It is the presence of this clay material and the ever-increasing groundwater pumpage which is causing the land subsidence.

As water is pumped from the Chicot and the Evangeline, the water pressure (which in essence holds the aquifer materials in place) decreases. As the pressure decreases, the clay particles compact together because of their shape and properties. The particles are now "flattened" and reoriented. In essence, the clay now takes up less space. This compaction of the clay material results in subsidence.

Effects of Subsidence

1) Flooding

In 1979 and again in 1983, a residential subdivision in Baytown (a suburb of Houston) flooded. Approximately 8 feet of subsidence has occurred in the area. At present, the subdivision has been condemned.

In the same general geographical area, 100 acres (or nearly one-third of the San Jacento State Park) has been permanently inundated by flooding.

In an area with elevation so close to sea level as the Houston-Galveston coast, any major storm or hurricane may cause severe flooding. The extent of such flooding increases significantly in the face of land subsidence.

2) Fissures

Fissures or faults are naturally occurring geologic cracks or breaks. Such fissures, often related to groundwater withdrawals, can damage homes, highways, pipelines and dams.

3) Economic Losses

Flooding, fissure damage and reduced property valuations represent substantial economic losses. In 1977, for example, economic losses in Houston due to subsidence were estimated to be $31.7 million.

Stopping the Sinking

Although the effects of subsidence are irreversible, prevention of further subsidence is possible by more effectively balancing groundwater withdrawals and groundwater recharge. Potential solutions include:

1) Reduction in groundwater withdrawals.
2) Conversion to surface water, thus "mixing" groundwater and surface water use.
3) Implementation of water conservation programs.
4) Supervision by regulatory agencies such as the Harris-Galveston Coastal Subsidence District, whose function it is to regulate groundwater withdrawals within their geographical jurisdictions.
5) Increased recharge of groundwater supplies. Although such recharge efforts will not "re-elevate" the land surface, they can serve to minimize or prevent further subsidence.

Excess groundwater withdrawals are depleting some aquifers at a faster rate than they can be recharged, resulting in land subsidence problems. Withdrawal rates can be modified by regulation, conservation, recharge efforts and a clear understanding of the need to bring society's water requirements more in line with the limits of the supplies that Nature has to offer.

Gail Dishongh is a sociologist involved with social assessments and public involvement activities for a water resource agency in the southwestern United States.

"LUST":

(leaking underground storage tanks)

A Threat to Groundwater Supplies

Every service station has them. Every community has them. So do farms. Underground storage tanks number in the millions nationwide, and an estimated 100,000 or more are leaking—and jeopardizing the quality of groundwater supplies throughout the country.

The meanings of particular words change over the years. One such word that has come to mean more today than it historically has is "lust." In lower-case form, its meaning is still basically the same. In its upper-case form, however, LUST means something much more volatile than an unharnessed emotion. LUST is the acronym for **l**eaking **u**nderground **s**torage **t**anks, and, in this context, "lust" has been the basis of much recent environmental concern.

Widespread Use . . .

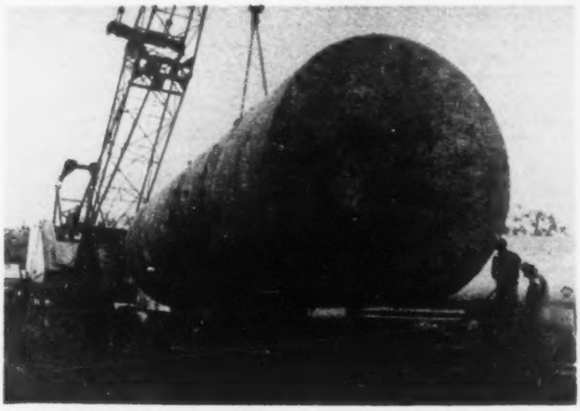
And for good reason. There are estimated to be anywhere from 1.4 to 2.5 million underground storage tanks in the United States. These underground storage tanks are used by industries, commercial establishments and individual residences for storage and treatment of products or raw materials, waste storage and treatment, and piping systems.

Industrial use of these storage tanks is primarily for fuel storage but also includes storage of a wide range of other substances, acids, metals, industrial solvents and chemical wastes. Commerical businesses and individual homeowners use underground storage tanks almost exclusively for fuel storage.

The most numerous underground storage tanks are those used for gasoline at service stations and for fuel oil at residences. An estimated 1.2 million steel underground storage tanks are found nationwide in service stations alone, concentrated in areas with high population density—and high automobile usage.

. . . And Growing Concern

The installation and use of underground storage tanks are often not regulated, and there are no design requirements at the federal level or in many states for storage facilities that might pose a threat to groundwater. Of further concern is that the typical design life of tanks varies from 15-20 years for unprotected steel tanks and is highly dependent on environmental conditions.



Corroded steel storage tanks are being voluntarily removed and replaced in many cases, as a direct response to growing awareness of the inherent risks of groundwater contamination as well as the increasing threat of liability for such contamination.

Underground storage tanks are known to have caused many cases of groundwater contamination. Experts estimate that as many as 100,000 underground gas tanks may be leaking nationwide, and the threat of leaks from older tanks may be increasing.

"Just one gallon of gasoline per day, leaking from a tank into the groundwater, can significantly contaminate the water supply for a community of 50,000 people."

The implication for human populations is very real. According to Senator Dave Durenberger (R-MN), who chairs the Senate Subcommittee on Toxic Substances and Environmental Oversight, "Just one gallon of gasoline per day, leaking from a tank into the groundwater, can significantly contaminate the water supply for a community of 50,000 people."

Florida: Especially Susceptible to LUST

Florida is particularly susceptible to the effects of leaking underground storage tanks. Florida's water table is very high, and its soil is porous and sandy, resulting in unusually vulnerable groundwater supplies. Add to these geologic realities the fact that 92 percent of Florida's population depends on groundwater for its drinking water supplies.

Leaking storage tanks may be causing the most serious risks to human health and the environment.

Ground-Water Protection Strategy
U.S. Environmental Protection Agency
August 1984

Florida has an estimated 60,000 underground storage tanks throughout the state—40,000 in service stations alone. Many of these tanks were constructed and installed more than 20 years ago, and many are beginning to deteriorate and leak. Numerous groundwater contamination cases have been reported, and concern over the susceptibility of Florida's groundwater—and drinking water—supplies is growing.

Replacement of aging steel underground storage tanks with such state-of-the-art fiberglass tanks as these from Owens-Corning is one technique which promises to assure protection of groundwater supplies from future contamination.

Belleview Boils Water—for Eight Months

The community of Belleview, near Ocala, Florida, exemplifies how an entire population can be severely affected by a gasoline leak which contaminates an underground source of drinking water.

10,000 gallons of gasoline which leaked from an underground service station tank in late 1979 and early 1980 found their way into the underground drinking water supply of Belleview in late 1982. The gasoline contaminated all three of the city's drinking water wells which served a population of 2500 people.

A ban on drinking the water from the wells was initiated immediately, and for more than a week, tanker trucks distributed fresh drinking water to the residents of Belleview. At that time a temporary alternative well site was opened, and the ban on drinking water was lifted, only to be replaced by a boil water edict.

The precaution of boiling drinking water was a response to the continuing health threats of possible bacterial contamination and the presence of volatile substances such as gasoline in the nearby alternate water supply.

Hooking Up a New Supply

Belleview was required to boil its drinking water for more than eight months while the entire water system of Belleview was reconstructed, hooking up downtown Belleview with a water supply from a new, remotely located well.

Even after Belleview residents began drinking water from the new well, the boiling requirement continued for nearly a month, until extensive tests of the new water supply were completed to assure that it was free from contamination and safe to drink.

Belleview may be back to drinking water "straight from the tap," but it seems unlikely that the residents of that community will take their drinking water for granted for a very long time.

Portions of this article excerpted from *Protecting the Nation's Groundwater From Contamination* (U.S. Congress, Office of Technology Assessment, Washington, DC, 1984). Special thanks for information provided by Rich Rossmann, staff writer for the Ocala Star-Banner, Ocala, Florida.

"SAFE COFFEE 40 CENTS"

This eye-catcher of a sign at the Belleview Waffle House may not have qualified as a glowing endorsement, but in the town of Belleview, Florida, in late 1982, it was important to reassure folks that the coffee—and the soft drinks and the iced tea—wouldn't hurt them.

The people of Belleview, whose chamber of commerce had once promoted the town's water as "the purest in the state," lost their public water system when gasoline contaminated the three wells from which the city drew its water.

Belleview got a new water supply—but only after eight months of boiling all drinking water from a temporary alternative well. In Belleview, a "Safe Coffee" sign was no joke. It was a much-needed assurance.

St. Petersburg Times, March 14, 1983

High-Tech's Impact on Groundwater

by Peter Steinhart

Human activity creates waste, and high-tech industry is no exception. Groundwater contamination in California's Silicon Valley raises questions of the potential risks to human health.

The fastest-growing industry in California's Silicon Valley may not be microprocessors or superchips, but drinking water. Machines vend drinking water outside convenience stores, and bottled-water sections in supermarkets are the size of semitrailers. Sales at Aqua Technology, a San Jose retailer of distilled water and purification systems, have been growing 80 to 100 percent per quarter.

"Trouble Brewing" in Silicon Valley

The growing doubts about the safety of tap water in Santa Clara County, California, are a grim side effect of the growth of the electronics industry. There are about 400 electronics companies in Sunnyvale, California, and more than 300 in Santa Clara. The county boasted that it had "the technology of the future" fermenting in its industrial parks and that it was smokeless, effluentless and clean. In the last two years, however, 42 wells have been closed because of chemical contamination, most of the closures from solvents leaking from underground storage tanks at high-tech companies.

Five years ago there was little fear for the quality of the Valley's tap water, half of which comes from wells. As late as 1982, a check of 120 wells by the Santa Clara Valley Water District showed no contamination—but trouble was brewing.

In 1980, IBM had reported a leak of trichloroethane (TCA), a suspected carcinogen, from an underground tank in San Jose. But, says Roger James, executive director of the bay region's Water Quality Control Board, "We didn't realize the significance of that incident until over a year later."

Groundwater contamination raises questions of the potential risk to human health.
Photo courtesy of National Water Well Association

Then, in December 1981, Fairchild Camera and Instrument Corporation reported that it had lost a significant amount of TCA, and a week later large amounts of TCA showed up in a Great Oaks Water Company well 2000 feet away. The leaks had gone on for one-and-a-half years, and the well, one of 12 serving 16,500 households, contained water that was 5600 parts per billion TCA. That was 28 times the "maximum recommended contaminant level" set by the Environmental Protection Agency (EPA). Since then, 500 citizens have sued Fairchild, charging that the leaks led to birth defects and cancer.

Since 1981, more than 100 toxic leaks have been detected in the county, and experts believe that, before the situation is brought under control, there may be more than 1000. Of the facilities with underground tanks that were checked, 75 percent were found to have leaked. By October 1984, 16 public water supply wells and 43 private wells were known to have been contaminated.

Silicon Valley— A Microcosm of California

As goes Silicon Valley, so may go California. There are at least 140,000 underground storage tanks for hazardous substances in California, and, according to Evan Nossoff of the state's Water Resources Control Board, "When we look at the old metal tanks that are storing the most toxic materials, we have consistently found that 60 percent leaked. Already 3.5 million residents of the San Gabriel and San Fernando valleys are exposed variously to TCE, PCE, chloroform and carbon tetrachloride in their water."

High tech isn't the only threat to California's groundwater. The state has just begun to check underground gasoline tanks and found them to be leaking benzene and other hazardous constituents of gasoline. In Sunnyvale, 20 percent of the service stations tested had leaks. One tank in San Jose dribbled 300,000 gallons into the ground before it was detected. Also, a recent state Water Resources Control Board report showed a sixfold increase in wells contaminated by pesticides—2893 of them in 25 counties.

Nearly half the residents of California drink groundwater. Where it is polluted, there is increased demand for developing surface water by building dams on the few remaining wild rivers. But the rate of contamination could exceed the supply of clean surface water.

> **"The water board estimates that aquifers that could serve over a million people have been closed due to toxic pollution. We're talking of a resource the size of a new dam, exceeding the water the Peripheral Canal would have made available."**

Says Nosshoff, "The water board estimates that aquifers that could serve over a million people have been closed due to toxic pollution. We're talking of a resource the size of a new dam, exceeding the water the Peripheral Canal would have made available."

Developing a Three-Pronged Response

The pollution may be better understood in Santa Clara County than it is elsewhere because the sources of contamination have been identified and the county acted quickly to monitor future spills. So the three-pronged response to the groundwater problem in Silicon Valley may set precedents that affect water quality all over California and the nation.

First, efforts went into regulations to improve the storage and handling of chemicals. The county and all 14 of its municipalities adopted an ordinance requiring companies to report to local fire marshalls what chemicals they had on hand and to monitor underground tanks for leaks.

The second front consists of monitoring for leaks and contaminated groundwater. The effort to monitor has been more problematic than the effort to regulate. There are at least 5000 underground storage tanks in the valley. The burden is on the companies to report tank leaks or chemical changes in the soil outside the tanks.

If a tank is leaking, however, its owner may not have the financial resources to sink dozens of test wells to trace the plume of underground pollution. Furthermore, where several companies are neighbors, it may be difficult to say which one caused the pollution.

The third front—cleanup—poses an even greater problem. Cleanup may require digging up leaky tanks, carting off the dirt and pumping huge amounts of groundwater into the air where the toxic chemicals volatilize. Carbon filters would have to be installed to remove chemical traces from the drinking water. Says James, "Cleanup is going to be very long-term, and it's going to be extremely expensive."

Who's Going To Pay?

The key question becomes "Who is going to pay?" Industry has spent $50 to $70 million on cleanup; IBM alone has spent $20 million, and Fairchild has spent $16 million. Smaller companies, however, are unlikely to have the cash IBM and Fairchild have and few companies have been willing to pursue contamination beyond their plant boundaries.

Most residents expect the EPA to step in and clean up the groundwater, and the state expects EPA funding of up to 90 percent of the cleanup.

The EPA administers the federal Superfund. 19 sites in the Santa Clara Valley are proposed for addition to the list. The EPA is spending $250,000 to plan cleanup activities in Silicon Valley and has another $1 million tentatively earmarked for the Valley.

More Superfund money, however, may be unlikely. Of the $1.6 billion originally authorized by Congress for the Superfund, nearly $1 billion has already been allocated to the 538 sites on the eligibility list.

Compounding the question of who pays is the question of how clean is clean. Most residents are reluctant to accept any toxic chemicals in their drinking water. State and federal agencies allow some chemicals in the water, but those amounts are subject to change.*

Groundwater Contamination and Public Health

Are portions of this country's groundwater contaminated? The answer to that question appears to be an unqualified "yes." The amount of groundwater known to be affected is relatively small, yet it is significant because the contamination most often occurs near heavily populated areas. And unlike surface water pollution, which in most cases can be stopped when the source is discovered and removed, groundwater contamination can last for decades.

And the effects on human health? The possibility undoubtedly exists that many of these contaminants may have a potentially adverse effect on human health, although definitive evidence is for the most part lacking or incomplete. According to Dr. Vernon N. Houk, director of the Center for Environmental Health, Centers for Disease Control, "Studies which generate information about the chronic low-dose toxic effects of chemicals do not permit predictions with full confidence about the health of an individual, but rather only about the health of a population and what degree of risk a given population will run if it continues to be exposed."

"We have hope that we can demonstrate strong associations, where they exist, between exposure and adverse health outcomes, so that reasonable people can take reasonable actions to protect public health and the environment."

It is not necessary, however to have "definite evidence" or "conclusive predictions" on which to base action. "Although the results of our studies may not provide conclusive answers about health risk," states Dr. Houk, "we have hope that we can demonstrate strong associations, where they exist, between exposure and adverse health outcomes, so that reasonable people can take reasonable actions to protect public health and the environment."

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*Excerpted from "Warning: Drinking The Water In This State May Be Dangerous To Your Health." *California Magazine*, March 1985, by permission of Peter Steinhart, environmental affairs writer for *California Magazine*.

Photo by Del Carlo Studio

Silicon Valley, sprawling out to meet San Francisco Bay, is the site of literally hundreds of high-tech electronics companies—and dozens of instances of groundwater contamination.

FRESHWATER FOLIO

Photo by John Baltzer

**Groundwater...
Beginning as rain...**

**Falling to the earth and
disappearing into the ground...**

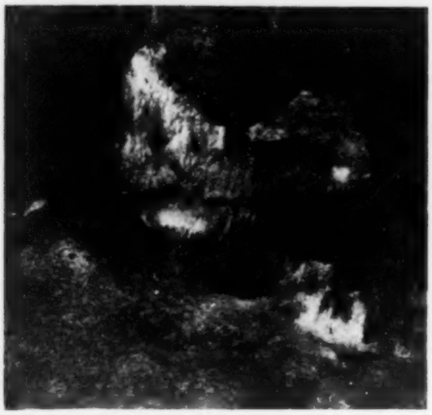


Photo by Grant Heilman

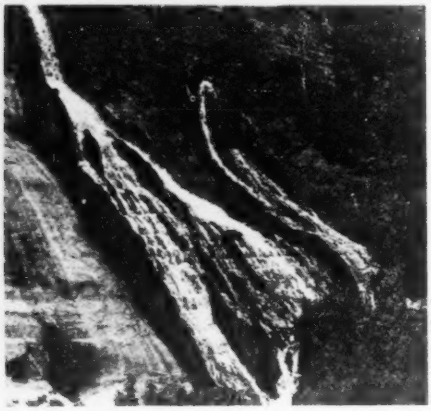


Photo by Curt Smith

Reappearing as a spring...

A wall of water...

Photo courtesy of U.S. National Park Service

Or a dramatic eruption...

Providing water for a multitude of uses...

And finally returning to the sky to begin the cycle again.

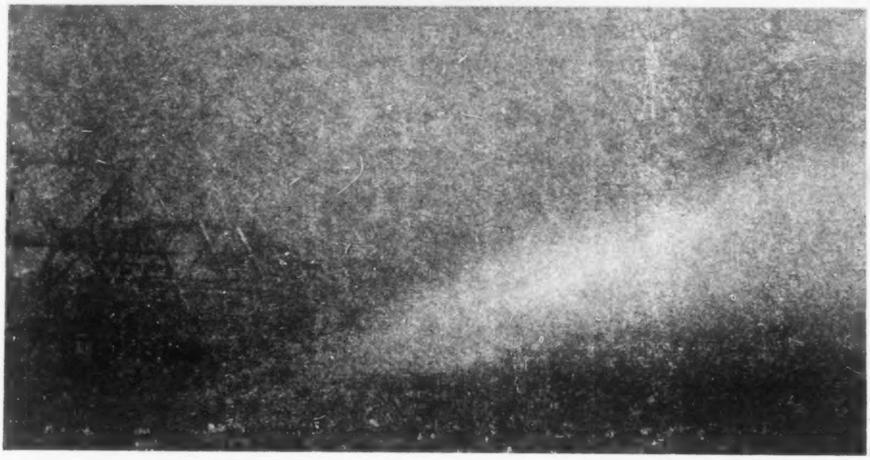


Photo by Grant Heilman

Dick Gray's Freshwater World

Agricultural Chemicals: A Growing Concern for Groundwater

by Richard G. Gray, Sr.

Farming is dependent upon chemicals—chemicals that present risks in production, in transportation, in use, and finally to those who depend on the groundwater supplies that become the final destination of these chemicals.

Driving through productive farming territory during mid to late summer, the scene is one of beauty and serenity. Corn stands tall with fat ears gracing the stalks; the maturing third alfalfa crop of the year looks like it will be a productive one; oats have matured and their harvested fields look like they've received fresh haircuts; and soybeans form a low green blanket over the land with an occasional corn plant or tall weed popping up amidst "the beans."

The pastoral beauty of the landscape belies the dangers lurking beneath the surface, dangers caused by the very things that make the above-ground picture seem so picturesque and prosperous: chemicals, chemicals, and more chemicals—chemicals promoting growth; chemicals controlling insects; chemicals killing pests; chemicals with multi-purposes—all with worthy goals to increase yields and better the quality of products.

There's nothing wrong with trying to be more productive and efficient; nothing wrong with adding boosters to Nature's own nutrient ways; nothing wrong in wanting to keep fields reasonably weed-free and growth reasonably pest-free. What can be wrong is **what** is used to accomplish these goals. Therein lies a serious problem.

"You Can't Fool Mother Nature"

Agriculture now uses innumerable man-made chemical concoctions that Nature has never seen and for which it has no "natural" method for breaking down.

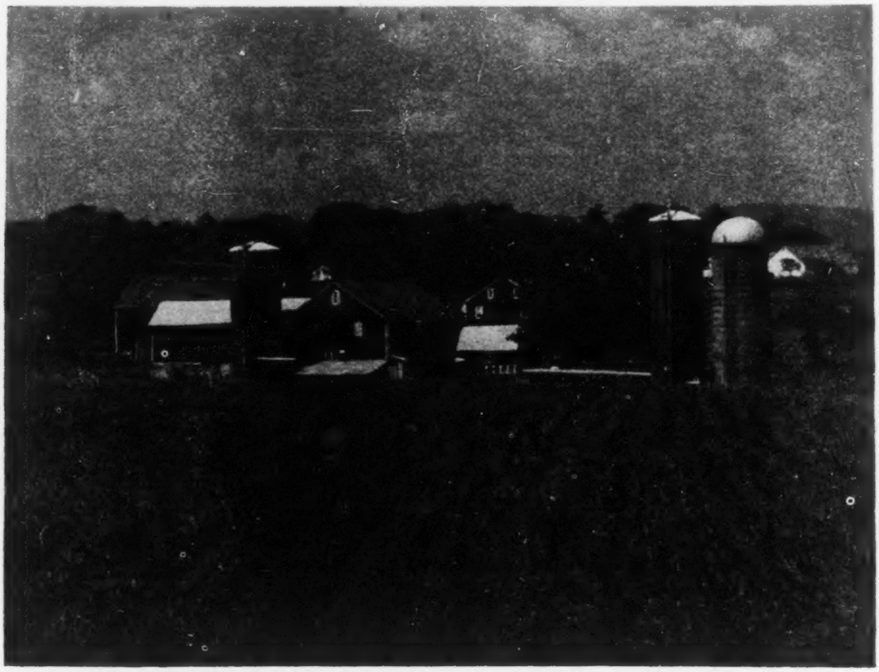


Photo by Isaac Geib/Grant Heilman Photography

A prosperous-looking farm, a healthy-looking field—and the unseen but ever-present risks associated with the use of agricultural chemicals.

Industry has its exotic molecular structures for new procedures and processes. The plastic trade in particular has the formulation of new and complex organic compounds that create new and sometimes wonderful solids. Medicine has its new drugs and new materials, which are revolutionizing the treatments of man.

All contribute good things, but all have also added new things to the environment that can be undesirable, dangerous, toxic or nonbiodegradable—distinct and real threats to health and our general quality of life.

There are thousands of manmade chemicals in daily use in agri-business today, and more are being formulated every year. Each new chemical must now pass certain procedures laid down by the Environmental Protection Agency at the federal level and various bodies at the state level.

No agency, however, can hope to properly check all angles, run down all possibilities, be aware of every single potential ramification of a new molecule that expresses itself as a new product with new results—and with a new and unknown impact on the environment on its own or in combination with other compounds already in the environment.

Chemicals in "Mind-Boggling Quantities"

The quantity of chemicals dispensed onto farmland today is mind-boggling. Although each acre of productive land is treated with "only" a few pounds of this or that during a growing year, the sum total is staggering because of the immense acreage of farmland in the United States.

Minnesota is one of this country's main agricultural states, and Minnesota farmers are heavy users of agri-chemicals. In 1984, nearly 40 million pounds of various chemicals were used on cropland in Minnesota alone, averaging about 2 pounds per acre.

The chemicals used were broadly listed as herbicides, insecticides and fungicides. Herbicides were by far the most commonly used chemical (90 percent of the total). About 64 percent of the herbicides were used on corn and about 25 percent on soybeans. Most of the balance went onto sugar beets, sunflowers, potatoes, peas, alfalfa and idled cropland.

570 Million Pounds Per Year

Minnesota's heavy use of chemicals represents only 7 percent of the total nationwide use of such agri-chemicals. Translated into national quantities, about 570 million pounds of agri-chemicals enter the environment annually by field application, loss in storage, spillage and miscellaneous uses.

Nothing is all good—or all bad—and farm chemicals are no exception.

The number one corn chemical herbicide (in Minnesota, at least) is alachlor. Trifluralin is the most popular soybean herbicide in Minnesota. Chemical insecticides are used mostly on corn, with terbofos as the leader, followed by fonofos, carbofuran and phorate. For potatoes, aldicarb is the most widely used in Minnesota.

Risks in Chemical Production . . .

Nothing is all good—or all bad—and farm chemicals are no exception. Their increasing contamination of groundwater is a real and growing threat, but that is only a part of the overall problem with such chemicals. Extreme care must be taken in their handling and application, as well as in their manufacture. In spite of detailed explanations and precautions listed on labels, in catalogs and in literature packaged with the products, misuse is common and errors are bound to happen.

The manufacturing procedures that include the formulation, mixing and processing of increasingly complex concoctions pose real dangers. Witness the catastrophe in Bhopal, India, that recently killed more than 2000 people when escaping gases flowed out of a manufacturing plant into the surrounding town and countryside. Witness the leak at a manufacturing plant in Institute, West Virginia, that hospitalized more than 100 people from fumes of a sister gas to that deadly one in Bhopal.

. . . Transportation . . .

Once manufactured, the chemicals aren't entirely safe to transport. Witness the everyday occurrence of overturned trucks and derailed freight cars that require evacuation of people downwind from the accidents.

Once transported to master distributors and dealers, the chemicals aren't entire-

Photo by Grant Heilman Photography

Herbicide application: What may be good news for soybeans is not necessarily so good for groundwater.

ly safe, either. Ruptured containers, warehouse fires, vandalism and just plain carelessness take their toll with toxic fumes, liquids and solids.

. . . And On-Farm Use

Once the farmer-user purchases the chemicals and they arrive on the farm, the products are still far from being safe. There, also, are dangers from fire, accidental rupture and carelessness.

Then, the user must be careful. The general precautionary statements accompanying the chemicals include the following: "May be fatal if swallowed. Harmful if inhaled or absorbed through the skin. Avoid contact with skin, eyes and clothing. Wash thoroughly with soap and water after handling and before eating or smoking. Avoid breathing spray mist. Remove contaminated clothing and wash before reuse." And other precautions: "Keep out of reach of domestic animals, particularly cattle. Consumption of this product, spray solutions or water contaminated with product can result in serious illness or possible death of such bovines."

In January 1985, a meeting of western fruit growers concentrated on pesticide poisoning among the growers. One main speaker warned, "It could happen to you" and died six months later from acute poisoning. As many as 100,000 acute poisoning cases have been reported annually in the United States. As stated at this conference, "Agriculture is far removed from the healthy outdoor activity most of us conjure up when we think of life on the farm."

The dangers posed by these necessary farm chemicals from manufacturing to the user don't end there. Potentially the worst danger is lurking in the background—underground, through the contamination of groundwater.

Chemicals, Gravity and Groundwater

Some farm chemicals sooner or later become part of the groundwater used for drinking and irrigation purposes throughout the United States.

The law of gravity dictates that what goes up must come down, and when down, must flow to the lowest part of the geography. Groundwater occupies the lowest part of the geography, lower than the lakes, lower than the streams and rivers, lower than the holding ponds or treatment reservoirs. Through spraying, broadcasting, dusting—by whatever means and under whatever conditions—some farm chemicals sooner or later become part of the groundwater used for drinking and irrigation purposes throughout the United States.

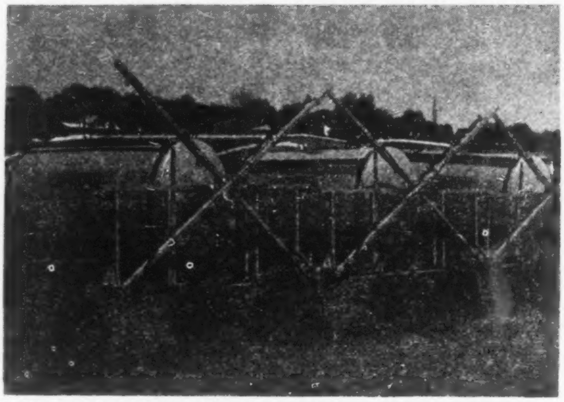


Photo by Dick Gray

Machinery for the application of liquid herbicides is colorful, expensive and integral to crop production today.

Depending upon the topography, the types and conditions of soils, the conditions of the environment at any one time (such as severe rainstorms, hot weather or drought) and the character of the chemicals used (rate of degradation, volatility, length of half-life, necessity for aerobic or anaerobic bacteria to degrade), any one chemical can persist and show up in any strata supplying potable water to a populace.

A recent study by the Iowa Geological Survey concluded that there were common herbicides present in groundwater and that they are present the year around. Specific herbicides found were alachlor (Lasso), atrazine (Aatrex), cyanazine (Bladex), metolachlor (Dual) and metribuzin (Lexone). Depending upon the topography, type of soil and geologic structure, 70 percent of the wells and springs tested contained detectable concentrations of one or more of these commonly used farm chemicals.

The Challenge of Seeking Solutions

What to do about the various dangers through the various stages of use of these necessary farm chemicals? Certainly, the first step is better education of the user as to the hazards of use, including the need for better clothing and better maintenance. Several states already have programs or are instigating them to instruct farmers in the proper use of chemicals and equipment.

Certainly, the manufacturers must pursue the concocting of less dangerous yet effective chemicals. Better containers, safer tank cars or truck tankers should be developed.

Finally, formulas must be devised for chemicals that will break down and degrade under both aerobic and anaerobic conditions; more chemicals with half-lives measured in hours instead of years; chemicals whose effectiveness is on the surface or immediately below; chemicals which become benign when their job is done so that groundwater contamination is minimized, if not eliminated.

The trick is to devise formulas that are safe to make, safe to transport, safe to handle, safe to use, and safe for the environment.

Half our nation's population uses groundwater for drinking water—97 percent of the rural population—and that same groundwater is the main source for irrigation. Contaminate these waters and there is nowhere else to go.

Research must continue—and accelerate—to find acceptable and much-needed chemicals to control weeds, pests and fungi, and to aid plant growth. The trick is to devise formulas that are safe to make, safe to transport, safe to handle, safe to use, and safe for the environment.

Dick Gray is founder and chairman of the board of the Freshwater Foundation.

[illegible]

Major Types of Groundwater Contamination

States	Organic Chemicals		Inorganic Chemicals						
	Volatile	Synthetic	Nitrates	Fluorides	Arsenic	Brine/Salt	Metals	Radioactive Materials	Pesticides
Alabama	●	●	●	●[a]		●	●	●	●
Alaska	●				●[a]				
Arizona		●	●[a]	●[a]					●
Arkansas		●	●	●	●	●	●	●[a]	
California	●	●	●[b]	●	●	●	●		●
Colorado			●			●	●		
Connecticut	●	●							●
Delaware			●						
Florida	●	●	●			●	●		●
Georgia	●	●				●			●
Hawaii		●							●
Idaho	●		●	●	●		●		
Illinois	●		●	●				●[a]	
Indiana		●	●			●			●
Iowa		●	●[b]	●[a]				●[a]	●
Kansas						●			
Kentucky	●	●				●	●	●	
Louisiana		●		●[a]		●			
Maine	●		●				●		●
Maryland	●		●						
Massachusetts	●	●	●	●	●		●		●
Michigan	●	●	●			●	●		●
Minnesota	●	●	●		●		●		●
Mississippi	●	●				●	●		
Missouri		●							
Montana	●		●		●	●	●		●
Nebraska	●		●[b]			●	●		●[b]
Nevada		●	●[a]	●[a]	●[a]	●[a]	●	●	
New Hampshire									
New Jersey	●	●	●	●	●	●	●	●	●
New Mexico	●	●	●	●[c]		●	●		
New York		●	●						●
North Carolina	●	●				●	●		●
North Dakota	●		●		●	●			
Ohio	●	●				●	●		
Oklahoma	●		●			●	●		
Oregon	●	●	●	●	●				
Pennsylvania									
Puerto Rico			●						
Rhode Island	●		●				●		●
South Carolina	●	●	●	●			●	●	●
South Dakota			●	●	●	●	●	●	●
Tennessee	●	●	●			●	●	●	
Texas	●	●				●			●
Utah			●		●	●	●		
Vermont	●	●	●		●	●	●	●	●
Virgin Islands	●						●		
Virginia									
Washington	●	●	●	●	●	●	●	●	●
West Virginia	●	●							
Wisconsin	●		●					●	●
Wyoming						●			
Total	33	30	34	16	15	28	28	13	25

Excerpted from *Overview of State Ground-Water Program Summaries*, Volume I. U.S. Environmental Protection Agency, March 1985.

[a] Natural mineral deposits [b] Agricultural activities [c] Sulfates

Major Sources of Groundwater Contamination

Major Sources of Groundwater Contamination

States	Septic Tanks	Municipal Landfills	On-Site[a] Industrial Landfills	Other Landfills	Surface[b] Impoundments	Oil and Gas Brine Pits	Underground Storage Tanks	Injection Wells	Abandoned Hazardous Waste Sites	Regulated Hazardous Waste Sites	Saltwater Intrusion	Agricultural
Alabama		●	●	●	●	●	●	●	●	●	●	●
Alaska	●	●					●					●
Arizona		●		●	●		●		●		●	
Arkansas				●		●					●	
California		●	●		●		●		●	●	●	●
Colorado	●		●	●	●	●	●		●			●
Connecticut		●	●		●		●					●
Delaware		●	●	●			●				●	●
Florida	●	●	●	●	●		●	●	●		●	●
Georgia	●				●			●			●	●
Hawaii	●							●				●
Idaho	●				●		●	●				●
Illinois	●		●				●	●		●		●
Indiana			●				●	●	●			
Iowa	●	●			●		●	●	●			●
Kansas						●				●		
Kentucky		●	●	●	●			●	●	●		
Louisiana				●	●	●	●			●		●
Maine	●	●	●		●		●		●		●	●
Maryland	●	●	●	●	●	●	●		●	●	●	●
Massachusetts	●	●	●		●		●		●			●
Michigan		●	●	●	●	●	●		●			●
Minnesota	●	●	●	●	●		●	●	●	●		●
Mississippi	●	●	●		●	●	●	●			●	
Missouri	●				●					●		●
Montana	●	●		●		●	●	●			●	
Nebraska	●	●			●	●	●		●			●
Nevada	●				●		●					
New Hampshire	●	●	●		●		●					
New Jersey	●	●	●	●	●	●	●	●		●	●	●
New Mexico	●				●	●	●		●			●
New York	●	●	●	●			●		●			●
North Carolina		●	●		●		●				●	
North Dakota	●	●	●	●	●	●	●	●	●			
Ohio	●		●	●	●	●				●		
Oklahoma							●				●	
Oregon	●	●	●				●	●	●	●		●
Pennsylvania	●	●	●	●	●	●		●				
Puerto Rico	●	●					●			●	●	●
Rhode Island	●	●	●		●	●	●		●			●
South Carolina		●	●	●	●		●		●	●	●	●
South Dakota	●	●	●	●	●	●	●					●
Tennessee	●		●		●	●	●	●	●	●		●
Texas	●	●	●		●				●		●	●
Utah				●		●	●					
Vermont	●	●	●		●		●		●			●
Virgin Islands	●										●	
Virginia	●				●		●					
Washington	●	●			●		●	●	●		●	●
West Virginia			●		●	●						
Wisconsin	●						●		●			●
Wyoming	●					●	●					
Total	36	31	30	20	36	21	41	18	25	15	19	33

[a] Excluding surface pits, lagoons, surface impoundments

[b] Excluding oil and gas brine pits

Current Status of Groundwater Policy Development

States	Specific State Statutes for Groundwater	Existing Policy for Protecting Groundwater Quality	Policy Under Development
Alabama			●
Alaska			
Arizona	●	●	
Arkansas			●
California		●	●
Colorado			●
Connecticut		●	
Delaware		●	●
Florida	●	●	
Georgia	●	●	
Hawaii		●	●
Idaho		●	
Illinois			●
Indiana			●
Iowa			●
Kansas	●	●	
Kentucky			●
Louisiana			
Maine	●	●	●
Maryland			
Massachusetts		●	
Michigan		●	●
Minnesota		●	●
Mississippi			●
Missouri			●
Montana		●	
Nebraska			●
Nevada		●	
New Hampshire		●	
New Jersey	●	●	●
New Mexico	●	●	
New York	●	●	
North Carolina		●	
North Dakota			●
Ohio			●
Oklahoma	●	●	
Oregon		●	
Pennsylvania			●
Puerto Rico			
Rhode Island			●
South Carolina			●
South Dakota			●
Tennessee			●
Texas			
Utah		●	●
Vermont		●	
Virgin Islands			●
Virginia	●		
Washington		●	●
West Virginia			●
Wisconsin	●	●	
Wyoming	●	●	
Total	12	27	28

Excerpted from *Overview of State Ground-Water Program Summaries*, Volume I, U.S. Environmental Protection Agency, March 1985.

Overview of State Ground-Water Program Summaries is a two-volume report of information compiled by the U.S. Environmental Protection Agency (EPA) from available sources on the basic elements of groundwater programs and activities in the 50 states and selected territories.

Volume I discusses the uses and contamination of groundwater and provides an overview of state policies and strategies for protecting groundwater. Volume 2 is a compilation of the background information used in preparing Volume I.

Although not a comprehensive summary of all state groundwater programs, the report should help states to exchange information and ideas on approaches for addressing common groundwater problems.

Published by the U.S. EPA's Office of Ground-Water Protection, the report is available from the Superintendent of Documents, GPO, Washington, DC 20401. Volume I (Stock No. 055-000-00246-1) is $2.75. Volume 2 (Stock No. 055-000-00274-2) is $22.00.

Groundwater and Chemicals: The Risk of the Unknown

by George R. Hallberg

Concern is increasing over the link between agricultural chemicals and groundwater. Cooperative efforts are needed to balance efficient agricultural production with the need to protect groundwater resources.

Photo by Charlton Photos

Surface-applied agricultural chemicals do find their way into groundwater, raising questions regarding long-term effects on public health.

In the past year or two, there has been much discussion in the news media about drinking water supplies being contaminated with agricultural chemicals. Interest peaked in the spring of 1984, when more than 40 public water supplies in Iowa went on notice for exceeding the drinking water standard for nitrates. The affected water supplies included Des Moines, the largest municipality in the country ever to exceed this standard.

Reports of increasing problems with nitrates in drinking water have been occurring over the last two decades. During the same time, however, the primary concern related to agricultural chemicals and water has been nonpoint source contamination, including the delivery of sediment, nutrients and other chemicals (particularly pesticides) into surface waters from extensive areas of cultivated and chemically treated land.

Focus on Groundwater

Only recently has attention been turned to groundwater. Groundwater is a major component of our hydrologic system, and most Iowans depend on groundwater for their drinking water supplies, either directly (through wells) or indirectly (groundwater sustains the base flow of Iowa's streams).

Concern over the link between agricultural chemicals and groundwater in northeastern Iowa focuses on regional limestone aquifers near the land surface and increasing difficulty in finishing wells of reasonable depth (and cost) without nitrate problems.

At the same time, Iowa and the Corn Belt have undergone great expansion in total corn acreage and a dramatic increase in the rate of nitrogen fertilization. Between 1960 and 1976, the amount of nitrogen applied in Iowa increased ten-fold—from about 100,000 tons to over 1,000,000 tons per year.

Research Results and Implications

For the past four years, the Iowa Geological Survey, in cooperation with other state, federal and local agencies and workers from Iowa State University, has been conducting extensive research on groundwater quality related to surface-applied chemicals. One of the unexpected findings of these studies has been that the most commonly used herbicides in Iowa are occurring in groundwater—and that they persist in groundwater year round.

There are legitimate concerns for public health over the long term.

If such groundwater quality problems continue or increase, there are legitimate concerns for public health over the long term. At present, only relatively shallow aquifers are affected, but this may simply be a function of time. If such chemicals continue to persist in groundwater, they will be in time transmitted to deeper aquifers.

The Risk of the Unknown

The pesticide concentrations, which are being routinely detected, are far below toxic levels and generally well below levels thought to contribute to long-term, chronic problems such as cancer. There are, however, many uncertainties involved with the combinations of pesticides, and possibly other metabolic products, that occur in groundwater in relation to other environmental factors.

Concerns for nitrate have generally been centered around drinking water for infants and the problems of methemoglobinemia ("blue baby" disease). Recent research does suggest, however, that high-nitrate drinking water may contribute to other long-term health problems in children and adults. Although these studies are not definitive, they do point out the need for further research of many unknowns.

Results from ongoing Iowa Geological Survey research and parallel research at Iowa State University are providing a definition of the problems between land application of chemicals and groundwater quality. The next step is to look for solutions.

The Need for a Holistic Perspective

A consortium of state, federal and local agencies, along with university researchers and extension personnel, is already at work on the design of needed research and demonstration projects. Agribusiness and industry also must play a role. A coordinated effort is needed to define cost-effective management alternatives, new technology and education programs that can be applied to these problems.

The groundwater quality problems related to agricultural chemical use can only be resolved through a more holistic approach to agricultural management.

The groundwater quality problems related to agricultural chemical use can only be resolved through a more holistic approach to agricultural management. Standard concerns for soil conservation and surface water quality must be coupled with the need to protect groundwater. New combinations of many current practices may be needed, and better chemical and nutrient management must play a part.

These problems will require a concerted effort by all segments of agriculture to acquire the experience and data necessary to effect a satisfactory balance between efficient agricultural production and the protection of underground water supplies.

Excerpted from "Agricultural Chemicals and Groundwater Quality in Iowa," a summary of a presentation made at Iowa's 37th Annual Fertilizer and Ag Chemical Dealers Conference, Des Moines, Iowa, January 1985.

Dr. Hallberg is chief of geological studies, Iowa Geological Survey, Iowa City.

Even everyday garbage can be hazardous. The culprits include pesticides, paint thinners, bleaches, and PCBs in old television sets. The disposal of such hazardous wastes in municipal landfills threatens underlying groundwater supplies.

Hazardous Waste in the Home: The Universal Culprit

Every garbage can in America is a potential hazardous waste site, and household hazardous wastes dumped in municipal landfills threaten underlying groundwater supplies. There's really no such thing as "just a little" oven cleaner or turpentine or insecticide anymore. It all adds up.

Garbage. Coffee grounds, pickle jars, half-empty paint cans, potato peelings, used motor oil, old medicine, newspapers, pesticides, magazines, weedkillers. The things we throw away every week. It's all garbage. But it's not all the same.

Waste—A Reality of Society

Waste—that which we throw away—is an inevitable reality of society. According to a U.S. Environmental Protection Agency (EPA) estimate, residential and commercial waste accumulates in this country at the rate of 3½ pounds per person per day, or 1,300 pounds per person per year.

Most of that waste is solid waste—all the discarded solid materials that end up in garbage cans and, eventually, in landfills. Coffee grounds, pickle jars, potato peelings and magazines are examples of common household solid waste.

Hazardous Waste . . .

Discarded paint cans, medicine, motor oil, pesticides, weedkillers, mothballs, flea collars and household cleaners may seem like just so much more everyday garbage, too, but they're not. These "everyday garbage" items are examples of household hazardous waste.

Hazardous waste is waste which includes toxic chemicals, corrosives, explosives, flammable substances and other potentially harmful materials. Hazardous waste includes acute hazards and chronic hazards. An acute hazard has the potential to cause immediate harm to human health and the environment. A chronic hazard has the potential to slowly cause harm to human health or the environment through repeated exposure over an extended period of time. Even very low doses of such chemicals over time are hazardous.

. . . In Our Homes . . .

Although most hazardous wastes are byproducts of industrial processes or agricultural practices, many household products contain small amounts of toxic substances. According to the EPA, the average American family accumulates several thousand pounds of solid waste per year. And, hidden among that year's accumulation of orange peels and junk mail is more than one full pound of hazardous waste disposed of by that family. (Some sources suggest that this estimate is low.) All of us play a part in the accumulation of hazardous waste. It's right here in our homes.

. . . and In Our Water

Most household waste—both solid and hazardous—ends up in dumps or landfills on the outskirts of towns and cities. Waste disposed of in an open dump, or even underground, can take many years to degrade or break down.

In the meantime, rainfall and melting snow, as it enters a landfill, becomes contaminated by these household hazardous wastes. It filters down through the wastes, moves through the soil, and can eventually contaminate the groundwater.

Once contaminated, groundwater may remain so for hundreds or even thousands of years. Lack of sunlight, oxygen and significant water movement inhibit the process of degradation, and contaminants present in amounts above acceptable risk levels may remain unchanged for generations, rendering that groundwater unsafe as a source of drinking water.

Half of all Americans rely on groundwater for their drinking water supplies. And some of these groundwater supplies are being contaminated—in part by the unregulated hazardous wastes that we dispose of in landfills.

How Much Difference Can One Household Make?

Every American household produces more than one pound of hazardous waste per year. At that rate, a landfill which services 20,000 families will accumulate 20,000 pounds—or 10 tons—of hazardous waste each year. And, often, that harmful waste material is not being disposed of, and monitored, as hazardous waste. Much of it is simply discarded with the solid wastes accumulating in landfills.

How much is being discarded? In the Seattle metropolitan area, 1.2 million people used 30,000 tons of household cleaners in 1980 alone. In Tacoma, Washington, 150,000 people use 264 tons of liquid household cleaners, 72 tons of toilet bowl cleaners, and 66 tons of motor oil each year.

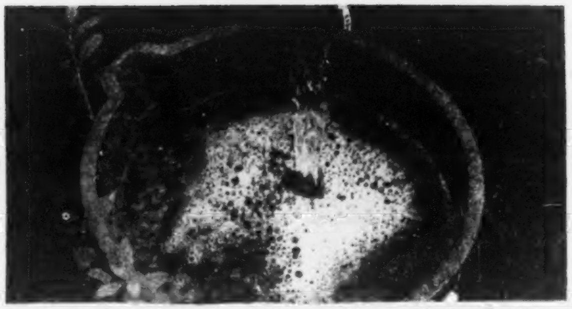
Hazardous waste in the home is a reality, and it doesn't just go away. It goes "somewhere," and often that "somewhere" is into the environment and, eventually, into our drinking water.

Since one gallon of gasoline can contaminate one million gallons of groundwater, it is easy to see how these household hazardous wastes can threaten our water supplies.

An Environmental Tar Baby

Hazardous waste is an environmental tar baby no modern society can shake off. It clings to us as paint sludge from appliance factories, as dregs of chrome and nickel from metal-plating shops, as spent raw material for varnish, carpets and detergents at chemical plants. We're dogged by solvents that have dry-cleaned our clothes and degreased microchips for computers. Mercury in an exhausted watch battery is hazardous waste. So is the butane residue in a disposable cigarette lighter and the lye in an "empty" can of oven cleaner.

"Storing Up Trouble...Hazardous Waste"
National Geographic, March 1985



"Long-lasting suds": This foaming groundwater, pumped from a monitoring well on Cape Cod, Massachusetts, is caused by the presence of nonbiodegradable detergents. The detergents originated about a mile from this site, where they seeped into the groundwater after being disposed of on land between 1948 and 1964. Thirty years later, when this picture was taken in 1978, the detergents were still present in the groundwater.

Photo courtesy of Dennis LeBlanc/U.S. Geological Survey

A Year's Supply of Hazardous Waste—And No Place To Play Football

No one knows the true sum of our toxic throwaways, but in 1981 alone the EPA regulated 264 million metric tons of hazardous waste—enough to fill the New Orleans Superdome 1500 times over.

"Storing Up Trouble: Hazardous Waste"
National Geographic, March 1985

Hazardous waste in the home is a reality, and it doesn't just go away. It goes "somewhere," and often that "somewhere" is into the environment and, eventually, into our drinking water.

Household Hazardous Waste: What You Can Do

What can one individual or one household do? A lot. And the cumulative efforts of many individuals, many households and many communities can do much to minimize the negative effects of our lifestyles on our groundwater supplies.

Here are some suggestions:

1. Understand the problem.

Begin by recognizing that the solid waste you dispose of does include significant amounts of hazardous waste and that these hazardous substances represent a potential threat to our groundwater supplies.

2. Know the sources.

Household items that can become hazardous waste include many specific automotive products, pesticides, fertilizers, home maintenance supplies, household cleaners, and certain personal care and hobby/craft products.

3. Dispose with care.

Dispose of hazardous wastes with care. Read label directions. If they seem unclear or incomplete, seek advice from public waste management or pollution control agencies. (Labels on older products, not subject to regulatory guidelines, may provide little or no information regarding ingredients or precautions.)

Although existing regulations for disposal of hazardous waste clearly exempt household products, household wastes containing hazardous substances should be disposed of properly to protect human health and the environment.

4. Buy with care.

To avoid having to dispose of a hazardous substance, practice careful buying. Read product labels, buy only as much as you can use, and consider whether a less hazardous substance might serve the purpose.

5. Consider non-toxic alternatives.

Consider safer alternatives to hazardous substances whenever possible. Substitute baking soda for a commercial oven cleaner, for example, or spray soapy water on bug-infested plants rather than insecticide. Many safe alternatives to common chemical products are readily available.

6. Participate in household hazardous waste pickups.

New community efforts are beginning for handling household hazardous wastes. In some locations, hazardous waste companies segregate household waste for proper disposal. Determine whether your community may currently provide such a service, or whether it might do so in the future.

Try this simple test when disposing of a household hazardous waste: Before you throw it away, ask yourself if you want it in your drinking water.

Household hazardous waste, disposed of improperly, can become a significant ingredient in the "chemical soups" that threaten to contaminate our groundwater supplies. The connection between hazardous waste and ground water is clear—and increasingly ominous.

Try this simple test when disposing of a household hazardous waste: Before you throw it away, ask yourself if you want it in your drinking water.

The Culprits in the Cupboard

Just a few of the household items that can become hazardous waste

Household Cleaners

drain cleaners
oven cleaners
disinfectants
mothballs/flakes
ammonia
deodorizers
spot removers
furniture polishes

Pesticides/Fertilizers

DDT
weedkillers
fungicides
insecticides
pet flea collars
flea shampoo
no-pest strips

Automotive Products

motor oil
batteries
anti-freeze
gasoline

Home Maintenance Supplies

asbestos
paint/varnish/lacquer
turpentine
wood stains
asphalt
roofing tar
swimming pool chemicals
wood preservatives

Learning from the Past, Looking to the Future

The Air Force and Hughes Aircraft: Working Together To Protect Groundwater

by Eric H. Schroeder

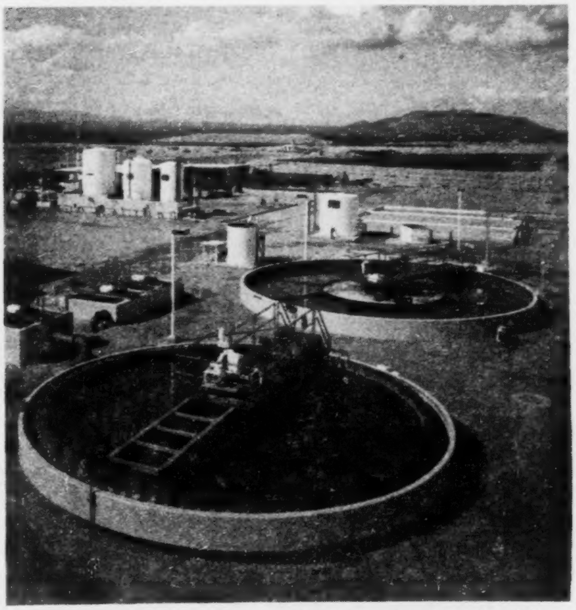
Innovative technologies are available to clean up—and prevent—groundwater contamination. Industry commitment to using these technologies, and to developing new ones, is growing. The cooperative efforts of the U.S. Air Force and the Hughes Aircraft Company are one example of such positive action on behalf of the environment.

With increasing frequency these days, corporations are being faced with accusations of environmental contamination and instructions to "clean up their act." Such instructions may be accompanied by fines or threats, and eventually the corporation either responds to the pressure to comply with the regulatory demands . . . or does not comply.

This story is different.

Air Force Plant 44, Tucson, Arizona

Air Force Plant 44, a government defense manufacturing facility, has been in operation in the area of Tucson, Arizona, for more than 30 years. During this time, Hughes Aircraft Company, which operates the plant for the U.S. Air Force, has been a primary producer of many of the missile systems used by the Armed Forces.



All industrial wastewater and chemicals generated at Air Force Plant 44 are channeled through a wastewater treatment facility for processing. This innovative treatment complex, shown in part here, is known as a "zero-discharge" type, since no incoming wastewater is discharged into the ground or city sewer system.

Photo courtesy of Hughes Aircraft Company

A number of the processes used in manufacturing these sophisticated missile systems require the use of various chemicals and metals, and produce industrial wastes as byproducts. Historically, and to a lesser degree today, these chemicals and wastes have included various solvents and certain types of metals, such as chromium.

"No One Thought Much About Hazardous Wastes"

Air Force Plant 44, while never a "smokestake" industry, nonetheless produced what are now considered to be hazardous chemical wastes. Like most others 30 years ago, Hughes and the Air Force were unaware of the potential hazards which have in more recent times been associated with the disposal of many solvent or metal wastes.

"When we first began operations over 30 years ago, no one thought much about solvents. The hazardous properties of some solvents were not known, and solvents of all types were freely and widely used for a variety of domestic and industrial purposes."

According the Barry Hatfield, former chief of Aeronautical Systems Division's Facilities Management at Wright-Patterson Air Force Base, Ohio (which oversees management of Plant 44 for the Air Force), "When we first began operations over 30 years ago, no one thought much about solvents. The hazardous properties of some solvents were not known, and solvents of all types were freely and widely used for a variety of domestic and industrial purposes."

Air Force Plant 44 (AFP 44) used a number of solvents, including large quantities of trichloroethylene (TCE), to clean metal and electronic components. When necessary, the TCE was disposed of in shallow evaporation pits or burn pits at the plant site.

While this disposal practice may seem surprising today, it was the accepted practice of its time. It was assumed that the high evaporation rates of solvents would cause them to dissipate harmlessly. There was little, if any, guidance or regulation concerning the use or disposal of these materials.

As was the case for solvents, the long-term impact of the inorganics (heavy metals) was not fully appreciated 30 years ago. Prior to beginning production in 1952, the Hughes Aircraft people met with Arizona State Department of Health officials and found that the only requirements concerned treatment of concentrated metal solutions produced by plating processes. Accordingly, such waste solutions were treated in a dilution tank and, along with rinse waters, were discharged into desert areas on AFP 44 property.

Awareness Begins To Grow

In the mid-1960s it became practical and economical to recycle solvents, and the potential health hazards of TCE began to be discussed. Hughes began replacing TCE with alternative solvents. TCE has not been used in significant quantities at the plant since the early '70s—and none has been used since 1981.

Heavy metals disposal practices also underwent some changes. In 1954, AFP 44 constructed a treatment plant for chromic and cyanide solutions. In 1956 several holding ponds were constructed to ensure that all waste products were contained on Air Force property.

So far the AFP 44 story reads like that of any other major industry. Industries were unaware of the far-reaching ramifications of manufacturing wastes. The general population and the experts were unaware of the potential health hazards of such substances and the possible danger they posed to groundwater. Policymakers, equally unaware at the time, were not developing guidelines and regulations for the handling and disposal of hazardous wastes.

The Air Force Takes the Initiative

The bright side of this particular case study is what Hughes Aircraft Company and the Air Force decided to do next.

80 percent of the industrial process waters are reused, and the treated water has a lower dissolved-solids content than city drinking water.

In 1975, prior to the adoption of federal waste treatment regulations and long before any groundwater contamination problems were discovered at AFP 44, the Air Force and Hughes Aircraft decided to build a completely new wastewater treatment facility. Completed in 1977, this waste treatment plant incorporated award-winning innovations that, even today, are considered state-of-the-art.

Photo courtesy of Hughes Aircraft Company

An environmental engineer at U.S. Air Force Plant 44 conducts an underground inspection of waste chemical discharge lines within a tunnel designed specifically to offer easy access for leak detection of piping.

Because of this new plant, 80 percent of the industrial process waters are reused, and the treated water has a lower dissolved-solids content than city drinking water. The remaining 20 percent, called the "brine," is piped to lined ponds where the water evaporates. This waste treatment plant is a "zero-discharge facility," one in which all industrial wastewaters are either recycled or contained within lined impoundments.

State-of-the-Art Features of the New Plant

- The Air Force-owned wastewater treatment plant addresses one of the principal problems facing the country today—visual inspection of tanks and pipelines. At AFP 44, the canopy which protects the missile assemblies and workers from weather also serves as a support structure for utility lines and wastewater collection systems. Having them up in the air provides for instant detection of leaks.

- The Air Force and Hughes Aircraft have also undertaken a program to remove all underground tanks and pipelines which contain hazardous materials. In cases where a pipeline cannot be brought above ground, two other steps have been taken to help verify the integrity of the pipeline:

  —First, pipes containing hazardous materials will be run through a walk-through tunnel over one-half mile long. This tunnel will permit daily pipe inspection.

  —Second, underground pipes that aren't being placed in the tunnel are being replaced with new "pipe-within-a-pipe" technology. In the space between the pipes is a leak detection system which will identify any leaks from the inner pipe. The system will not only signal the leak, but will also tell the location of the leak along the length of the buried pipe.

- Underground storage tanks are being replaced by new above-ground tanks which are gathered together in tank farms. Individual epoxy-coated concrete containment areas are provided for each type of chemical or fuel being stored. If a tank were to leak or rupture, the containment system would hold the contents until repairs could be made.

- As a further upgrading of the lined impoundments, Hughes and the Air Force are double-lining the ponds with two 100-mil-thick liners separated by a mesh. Any liquid that leaks through the top liner will migrate without release to the environment to a low point in the system where it can be detected. Officials of the Environmental Protection Agency (EPA) made frequent visits to AFP 44 to observe construction of these impoundments, and are expected to incorporate many of the features of this system into the EPA's forthcoming regulations on double-liner requirements.

Other changes are being planned for the waste treatment plant to increase its recycling efficiency, and to reduce the amount of brine placed into the double-lined evaporation beds. The target is to raise the amount of water being recycled from 80 percent to 95 percent.

TCE Contamination Discovered

In the spring of 1981, the EPA discovered evidence of TCE contamination in groundwater beneath AFP 44. The source of the contamination was determined to be the pre-1977 disposal practices, particularly the prior practice of disposing spent solvents into shallow evaporation pits.

The new treatment facility, the lined impoundments and the complete cessation of on-site solvent disposal in the mid-1970s have all ensured that waste handling practices employed at the facility no longer result in releases of hazardous wastes into the environment.

Since 1981, the Air Force has completed major environmental investigations of groundwater contamination caused by past AFP 44 waste disposal practices, as well as a number of studies as to appropriate alternatives for remedying the existing conditions. The EPA, the Arizona Department of Health Services, the Arizona Department of Water Resources, the City of Tucson and others have assisted in these efforts, and are conducting their own investigations and analyzing remedial alternatives for dealing with groundwater contamination caused by other sources in the vicinity of Tucson International Airport.

A Pilot Reclamation Project

To verify the feasibility of one groundwater restoration alternative, involving the treatment of contaminated groundwater, the Air Force and Hughes initiated construction of a pilot reclamation project, a much smaller version of a full-scale reclamation effort that will be proposed for implementation at AFP 44.

This pilot plant consists of two separate groundwater treatment systems. The first system is an ion-exchange unit, which removes inorganic contaminants from groundwater. The second treatment system is an air-stripping tower that removes the organic contaminants from the water.

Because the two units are interconnected, the contaminated groundwater is treated to a level which meets or exceeds drinking-water quality. The treated water is then pumped to four recharge wells which return water to the aquifer. In this way, the groundwater will be available for use in the future to help satisfy Tucson's water needs.

A Look to the Future

This pilot program is only a first step. Subject to public input, the full-scale project will include the use of at least 35 well sites, 19 for extraction and 16 for recharge, together with a greatly expanded treatment plant. Instead of the 400-500 gallons-per-minute treatment capacity of the pilot plant, the full-scale plant will treat approximately 5000 gallons per minute.

> **The lesson from the past is that it is not enough just to sit still or simply react to changing requirements concerning waste management.**

The Air Force and Hughes are continuing to look ahead. The lesson from the past is that it is not enough just to sit still or simply react to changing requirements concerning waste management. The operations at AFP 44 are continually being reviewed in an effort to reduce waste generation, to minimize the need for off-site recycling, and to ensure that no future pollution occurs as a result of AFP 44 activities.

Many of the ongoing research projects at AFP 44 are a part of an effort by Hughes and the Air Force to remain at the forefront of waste management technology. Many Hughes engineer-designed projects are being recommended to other companies as state-of-the-art advances in waste management technology.

Finally, the Air Force and Hughes emphasize, improvements in hazardous waste management technology and environmental protection are the result of a team effort. According to Mr. Hatfield, "Neither the Air Force nor Hughes Aircraft Company by themselves could have accomplished what has been done without the assistance of the EPA, the Arizona Department of Health Services and the Arizona Department of Water Resources. These groups, together with countless other organizations and agenices, have enabled us to take a most aggressive approach toward protecting our environment."

Eric Schroeder is a staff writer for the Freshwater Foundation.

Managing Overdraft: Tucson "Slows the Flow"

by Elaine Holub

Tucson has only one water supply: groundwater. By "Beating the Peak" and "Slowing the Flow," Tucson residents are realizing its importance and learning to live with it.

Ten years ago, most Tucson residents assumed that water magically appeared from their faucets. They had little idea that the water they freely used at a rate of 205 gallons per person per day was pure, untreated groundwater pumped up from under their neighborhoods and delivered directly to their homes. Rates were so low that many people thought water was almost free.

Changing Water Use Patterns

Today, people in this desert city of more than 600,000 people realize that their sole source of water is a vast pool of water lying beneath the city and nearby valleys. Residents of Tucson, the largest city in the United States to rely entirely on groundwater, no longer consume water at the rate they once did.

The change in water use was not easy, and was based on several events. A 1976 change in the water rate structure touched off a massive public outcry and triggered a willingness to reduce use. The city of Tucson's "Beat the Peak" program was launched a year later. Shortly afterward, an indoor "Slow the Flow" conservation campaign was initiated. Three years ago, a "Changing Landscapes" campaign became a part of the effort to change public attitudes. With such programs as these, Tucson has successfully halted a water use pattern that had been in effect for decades.

Dealing with Overdraft

Historically, Tucsonans have pumped groundwater at a rate that far exceeds Nature's ability to replenish it. The amount of overdraft has been two to three times the amount of natural recharge. The water table fell an average of two to five feet per year from the 1950s through the early 1970s.

Tucson responded to its water supply situation the same way every other city in the West has done—by going out and getting more water. By 1991, Tucson will

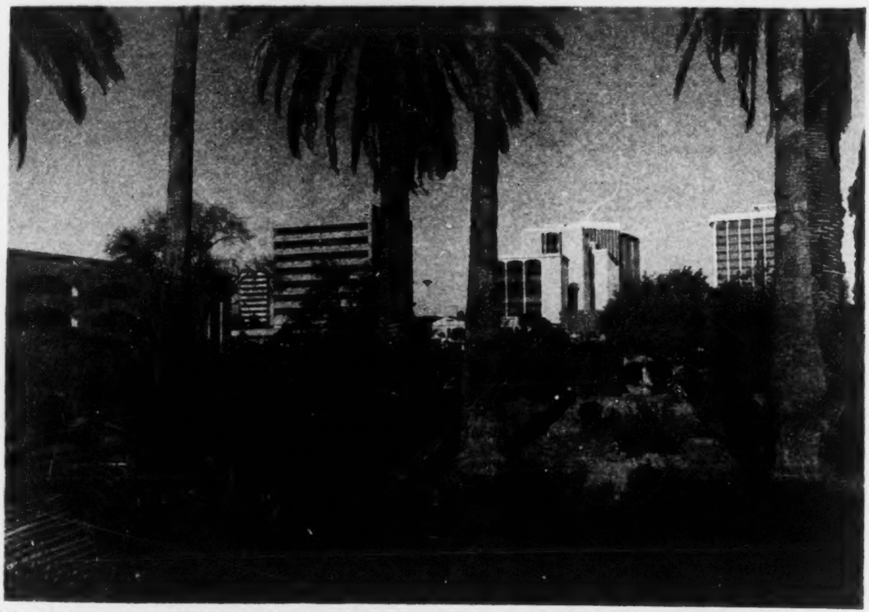


Photo by Alan Pitcairn/Grant Heilman Photography

Rather than trying to be a "green oasis," the prevailing attitude in Tucson today is that "we live in a desert, so we should look like a desert."

be connected to the Colorado River via the $3 billion Central Arizona Project, which will provide a new surface supply of water to the city's tap.

At the same time, however, Tucson began to realize that "getting more water" was not the only solution. Conserving water had to become a part of Tucson's water picture.

"We Should Look Like a Desert"

For many years, conserving water was discussed in the community, mostly from the point of view that "we live in a desert, so we ought to use water like we live in a desert." In the early 1970s, however, Tucson looked like a Midwestern city, with lush grass in every front yard and high-water-demanding shade trees and flowers transplanted from wetter climates. Tucson had grown into a green oasis.

Demand on its water system began pushing the limits of the physical capability of the system to provide all the water people wanted.

By the mid-1970s, with the overdraft of the aquifer increasing, the growth of Tucson exploding and the creation of a green oasis accelerating, Tucson faced a crisis: Demand on its water system began pushing the limits of the physical capabilities of the system to provide all the water people wanted, especially if everyone chose to water lawns at the same time on the same day.

Just like an electrical power system, a water system in a hot, dry climate experiences a peak demand period, and a high point of demand each summer. In Tucson, the peak demand day is usually in late June or early July, after weeks of 100-degree weather and months without rain. The entire water system has to be large enough to provide water for that peak demand period. The rest of the year, the peak capacity is not needed.

"Beat the Peak" Arrives

Nine years ago, Tucson's water utility officials figured that, if people would avoid using water outdoors at the same time on the same day, they could reduce the peak demand on the water system and avoid having to spend vast amounts of money to constantly expand the system. In addition, if people did not use a lot of water during the hottest part of the summer, total water demand would drop, and the life of the aquifer could be extended.

A year later, in 1977, Tucson officials changed the water rate structure to include a summer/winter differential with high summer rates. In addition, they added an inverted rate during the summer: The more water a customer used, the more the water cost.

The public campaign to explain the concepts of these changes was named "Beat the Peak." Each summer, from June 1 to August 31, people are inundated with songs, T-shirts, stickers, balloons, frisbees and bumper stickers to remind them never to water between 4 p.m. and 8 p.m. and never more than every other day.

From the start, the results have been encouraging. In 1976, the peak summer demand in Tucson was 138 million gallons per day, and the per capita usage was 205 gallons.

After one summer of Beat the Peak, the per capita use dropped to 150 gallons per day. In 1984, the peak demand was 111 million gallons (a 20-percent decrease), and the per capita use was down to 149 gallons per person per day (a 27-percent decrease). These consistently decreased demands have occurred over the past nine years even though the Tucson area population has grown by almost 100,000.

"Slow the Flow" Reduces Indoor Use

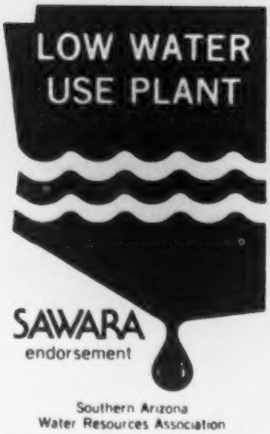
Based on the success of Beat the Peak, the Slow the Flow program was created to reduce the peak demand on the city's sewer system. Reducing the amount of water used indoors reduces the amount of water that flows through the sewage treatment plant, thus slowing the need to increase the capacity of the plant to serve a growing population.

Water-saver kits, distributed free throughout the community, contained a one-gallon plastic bag that, when filled, displaced water needed to flush the toilet. It also included washers and dye tablets to check for toilet tank leaks.

Entire neighborhoods have been provided with these kits. Data are presently being gathered on the amount of water saved through these simple indoor conservation techniques.

Changing Tucson's Landscapes

With the advent of high summer water rates and appeals not to water lawns in the late afternoon and early evening, many people initially stayed indoors and let their lawns die. Then they began replacing grass with desert-style landscaping. The city replaced the grass in the street medians with low-water-using plants and drip irrigation systems. Some medians have achieved a reduction in water use of 90 percent.



The "Changing Landscapes" campaign encourages the use of low-water-demanding plants by marking the plants with a blue tag at local nurseries for easy identification.

A "Be Water Aware" program of the Southern Arizona Water Resources Association created "Changing Landscapes," a campaign to encourage the use of low-water-demanding plants by marking the plants with a blue tag at local nurseries. Plants on a low-water-using plant list, developed by experts, are currently being considered for inclusion in city and county planning and zoning ordinances. Such action could result in future landscapes being created with mostly low-water-using plant materials. Most new construction already incorporates low-water-using plants and landscape styles.

Someone who wastes water in Tucson is quickly identified as a newcomer and politely advised of the "right" thing to do.

Tucson has undergone a 180-degree turnaround in its water ethic—from a community which proudly squandered water to a community which proudly conserves it. Someone who wastes water in Tucson is quickly identified as a newcomer and politely advised of the "right" thing to do. Many Tucsonans now believe it is socially unacceptable, if not immoral, to flagrantly abuse their groundwater resources.

Elaine Holub is a development consultant for the Southern Arizona Water Resources Association and a native of Tucson.

El Paso Puts Wastewater To Work

by Jonathan W. Rogers

To augment its dwindling water resources, El Paso is reprocessing sewage for recharge into its groundwater supplies—and convincing people it's a good thing to do.

FRED HERVEY
WATER RECLAMAT
PLANT

Photo courtesy of Parkhill, Smith & Cooper, Inc.

Reclaimed water at the Fred Hervey Water Reclamation Plant seems to be passing the taste test among the many visitors who have toured the plant and been offered a glass of the "final product."

El Paso celebrated the 100th anniversary of its water system this year by dedicating a new 10-million-gallon-per-day water recycling plant. In so doing, the city has become what is believed to be the first large community in the nation to stretch its dwindling water resources by pumping reprocessed sewage into its major underground aquifer.

The Decision To Reclaim Sewage for Drinking

The possibility of drinking water that was once called "sewage" might frighten most urban communities. In fact, when Coalinga, California, began using reprocessed sewer effluent in its water supply system more than two decades ago, residents initially refused to drink it. The city wound up using what was actually super-pure water to fight fires, wash cars, and water lawns and golf course fairways.

Among the 480,000 El Paso residents, however, little dissent was raised in response to several days of front-page publicity about the proposal for a new water treatment plant.

Providing about 65 percent of El Paso's water supply, the aquifer is presently being depleted about 20 times faster than the natural rate of recharge.

The proposal climaxed a 12-month study by a committee of 17 people representing all interests in the community. At the study's conclusion, the committee voted unanimously to recommend that El Paso begin reclaiming its sewer effluent to recharge the Hueco Bolson Aquifer. Providing about 65 percent of El Paso's water supply, the aquifer is presently being depleted about 20 times faster than the natural rate of recharge.

The only controversy regarding the proposal arose over the concerns of rod and gun clubs and the Audubon Society that construction of the plant would eliminate manmade sewage lakes that had become habitats for waterfowl. When the issue arose in the committee, however, a majority voted for people rather than for birds.

El Paso's "Water History"

In a desert area like El Paso, where rainfall is usually less than eight inches per year, an adequate water supply has always been a problem. A century ago this city's first water system delivered water filtered through the natural sands of the Rio Grande riverbed. Even at a time when there were no nationwide water quality standards, most residents found that water supply to be less than desirable. They preferred to haul well water in from a New Mexico community almost 100 miles away.

Before the turn of the century, however, experimental wells were drilled to the north of the Rio Grande. These produced relatively good quality water. Gradually, more wells were drilled further away from the river to supply the city's expanding needs.

By the 1940s, indications that the water levels in these wells were declining rapidly caused the city to take water once again from the Rio Grande. A conventional water treatment plant was built for this purpose in 1943.

Water Supply Struggles . . . and a Solution

The amount of water El Paso could take from the river, however, was relatively small. Farms and the federal government had already appropriated all of the water for agricultural use and were not inclined to give up a significant part of the water rights to the city of El Paso.

Continued decline of water levels in the well fields as more and more wells were drilled caused a constant struggle between the urban and agricultural communities over the waters of the Rio Grande, the only replenishable surface water supply in the El Paso area.

Finally, in the mid-1950s, the question went to the U.S. Supreme Court. The Court determined that El Paso had no rights to the waters of the Rio Grande except those that the agricultural interests were willing to grant, but that the city did have the right to use its sewage effluent until it was discharged into the river.

The failure of negotiations to exchange sewage effluent for Rio Grande water led to the ultimate decision to construct the Northeast Water Reclamation Plant and to use its output to recharge the dwindling aquifer resources. It is anticipated that additional plants of this type will be constructed if the experience in operating the Northeast Plant is favorable.

Reprocessing Sewage To Augment Supplies . . .

The Environmental Protection Agency (EPA) supported El Paso's proposal to build this plant from the beginning. Through the Texas Department of Water Resources, the EPA approved a grant of $20.5 million to pay part of the $32 million total cost of plant construction. The plant is owned by the City of El Paso Public Service Board.

The treatment system uses biological and activated carbon processes to remove all organic and nitrogen compounds. Operating costs are projected at 85 cents per 1000 gallons, which is well within the range of water charges under El Paso's graduated water rate system.

The plant's output should provide enough water to meet the needs of about 50,000 people.

Although water usage in the El Paso area varies considerably at different times of the year, the plant's output of 10 million gallons per day should provide enough water to meet the needs of about 50,000 people (10 percent of the area's population), based on average year-round individual usage.

. . . And Working To Reduce Water Consumption

In addition to El Paso's water resource management program, the city has implemented additional programs to reduce water consumption:

- The water rate structure includes a five-step increasing rate for residential customers and a three-step increasing rate for all other customers.
- 100 percent of the customers are metered; even the city itself pays at the increasing rates for all of the water used for parks and golf courses.
- Concrete ground storage reservoirs are lined with plastic to reduce water loss.
- 8 to 10 miles of deteriorated water lines are replaced each year.
- About 18 percent of the single-family residents are landscaped with native vegetation that uses less water than other plants and groundcovers; the city has been encouraging such landscaping since 1970.

These and other conservation actions have reduced water use in El Paso nearly 15 percent, from 216 gallons per person per day in 1977 to 185 gallons in 1984. These conservation measures, along with the new system of using treated sewer effluent to recharge groundwater resources, should serve to help guarantee a continued adequate water supply for the El Paso metropolitan area.

Jonathan Rogers is mayor of El Paso, Texas. Excerpted from the EPA *Journal*, April 1985.

Photo by Grant Heilman Photography

The aquifer which supplies 65 percent of the water supply for the sprawling El Paso metropolitan area is being depleted at about 20 times the rate of natural recharge. The decision to reclaim sewage to augment future groundwater supplies will help to assure sufficient water for El Paso's future.

Public Drinking Water: Assessing Health Risks

The widespread occurrence of organic chemicals in drinking water is a growing concern. A comprehensive Minnesota study of the state's community water supply systems will aid in protecting public health and provide encouragement for other states to do the same.

Three out of four Minnesotans depend on groundwater for their drinking water supplies, and based on awareness of growing concern about groundwater contamination, the Minnesota Department of Health has recently completed a survey of the presence of 48 volatile organic chemicals (VOCs) in community public water supply wells in Minnesota.

VOC Contamination

Volatile organic chemicals are chemicals that evaporate rapidly when exposed to air at room temperature. They are present in groundwater as a result of the production and later disposal of millions of tons of these chemicals for use in a wide variety of industrial, commercial and residential products such as paint thinners, cleaners, degreasers, refrigerants, drying agents, inks, dyes, varnishes, preservatives, pesticides, fire retardants, detergents and shampoos.

Studies done by state and federal agencies have concluded that VOC groundwater contamination results from improper surface or underground disposal of wastes and leaking underground petroleum storage tanks.

The widespread occurrence of VOCs in drinking water is of concern because of the potential health risks associated with human exposure to them at very low levels (parts per billion). Several of these chemicals are suspected to be carcinogenic (causing cancer), mutagenic (altering genetic structures), and/or teratogenic (altering fetal development) to humans.

VOC persistence and mobility in groundwater create the potential for long-term human exposure to people who use groundwater as their drinking water source.

Once groundwater is contaminated by organic compounds, it is likely to remain so for a long period of time, since no natural cleansing processes are known to be associated with its movement through the earth. VOC persistence and mobility in groundwater create the potential for long-term human exposure to people who use groundwater as their drinking water source. 94 percent of Minnesota's public-supply water systems derive their domestic water supplies from groundwater.

Impetus for the Survey

The statewide survey was initiated as a result of the U.S. Environmental Protection Agency's (EPA) Groundwater Supply Survey, which randomly selected 466 community water supplies throughout the United States. (A community public water supply serves at least 15 service connections used by year-round residents, and includes, for example, municipal systems, mobile home parks, apartments and extended health care facilities.)

Results of the EPA survey indicated that approximately 21 percent of the water supplies tested contained at least one VOC above detectable levels. (In addition, 479 groundwater supplies were selected non-randomly for the survey, and the results showed even higher frequencies of occurrence.)

The EPA survey paved the way for state involvement in VOC testing of community water supply systems, and, according to Gary Englund, chief of water supply of the Minnesota Department of Health's Division of Environmental Health, Minnesota was quick to act. "Our unique ability to appropriate special funding for environmental concerns enabled Minnesota to obtain funding for this special study 2-3 years ahead of most states," he said. "Our

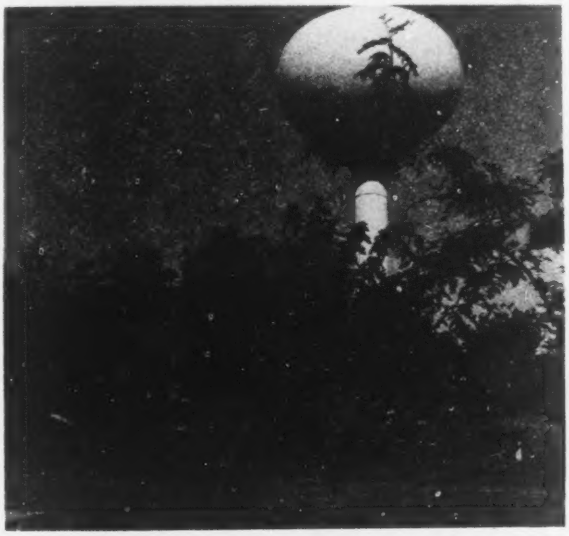


Photo by Bob Firth

Three out of four Minnesotans depend on groundwater for their drinking water supplies. Results of a recent Minnesota Department of Health study will help to provide additional public health protection for those whose community water supplies depend on groundwater.

funding and investigative abilities led to Minnesota being one of the first states to complete a comprehensive survey of all community water supply systems."

VOCs in Drinking Water: A Health Risk

The impetus for conducting the VOC survey was based on two primary considerations: (1) suspicion of widespread occurrence of these compounds in groundwater and (2) concern for the associated health risk created by consumption of VOCs in drinking water.

The purpose of the survey was to sample community water supply wells and analyze the samples for the presence of a group of synthetic volatile organic chemicals commonly referred to as VOCs. For those community wells in which significant VOC contamination was detected, the Department of Health would follow up with the issuance of drinking water health advisories and provide assistance to the affected communities to obtain an acceptable water supply.

Testing 1800 Community Wells

The initial strategy for the VOC monitoring survey was based on sampling those wells serving the greatest number of persons and having the highest likelihood of being contaminated. This strategy was accomplished by selecting community wells which were located within the following areas: (1) the 10 most populous counties in Minnesota; (2) major industrial areas (the 7-county metro area and a 25-mile radius around the 10 largest out-state industrial centers); and (3) a 20-mile radius around suspected or known hazardous waste dumps identified by Minnesota Pollution Control Agency (MPCA).

Using these criteria, 1100 community wells were targeted for sampling and analysis. The 1100 wells represented slightly more than half of the 2050 wells in Minnesota that serve community water supply systems. (Due to laboratory efficiency and lower-than-projected costs, the scope of the survey was later expanded to include all community wells not previously tested, bringing the total to 1800.)

Because of the sensitivity of the VOC analytical method and the extremely low, detection limits of the equipment (less than one part per billion), any initial sample showing a positive response was resampled to confirm that the VOCs detected in the sample were present in the well water and not due to laboratory contamination or sampling error.

No data were released or action taken until two sets of analytical results confirmed the detection of VOCs in a well. In some cases, in fact, it was necessary to resample a number of times to better define the degree of VOC contamination in a well or water system, in order to obtain sufficient information for recommending a course of action to be taken concerning the VOC contamination.

No Regulatory Standards for VOCs

At present there are no federal or state regulatory standards establishing maximum permissible levels for VOCs in drinking water. Lacking regulatory standards for VOCs, the Minnesota Department of Health has dealt with the public health concerns presented by these compounds in drinking water by utilizing available health risk criteria from the EPA to establish acceptable exposure levels for a number of the VOC compounds.

The health risk associated with VOCs at the low levels found in groundwater is based on long-term continuous exposure and normally does not pose an acute or immediate threat. Since, however, a number of the VOCs are suspected human carcinogens, it is assumed that continuous consumption of water containing one or more of these compounds over a long period of time will increase the cancer risk of the consumer.

Estimates of "Excess Cancer Risks"

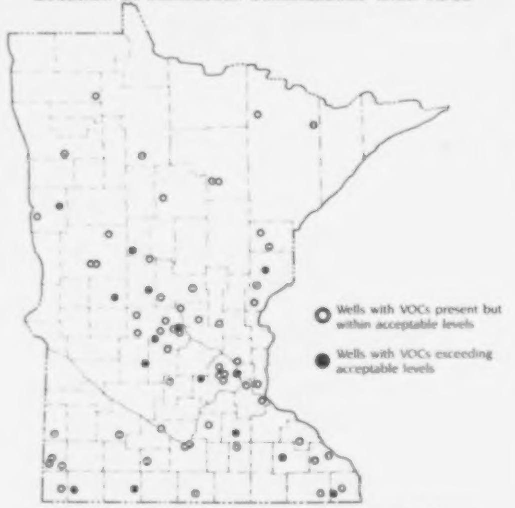
Because medical research has been unable, up to this time, to determine what a safe exposure level to a carcinogen is, the health risk criteria now available are based on estimates of excess cancer risk associated with a given concentration of a chemical.

For the purpose of this survey, the Department of Health established as the acceptable level for any single VOC compound that concentration of the chemical corresponding to a risk of one additional case of cancer in an exposed population of 100,000 people.

For example, a concentration of 6.6 parts per billion (ppb) of the volatile compound benzene corresponds to one excess cancer in 100,000 people exposed, so the maximum acceptable level for benzene was set at 6.6 ppb.

Immediate Responses to Contamination Discoveries

In communities where concentrations of VOC compounds exceeded acceptable levels, and where neither existing treatment systems nor dilution with water from uncontaminated wells could bring the



Location Of Minnesota Communities With VOCs

○ Wells with VOCs present but within acceptable levels
● Wells with VOCs exceeding acceptable levels

For the most part, communities with affected wells were evenly distributed throughout the state, confirming the initial suspicion that VOC occurrence in groundwater may be widespread.

VOC concentrations down to acceptable levels, the Department of Health recommended that the well not be used as a potable water source.

For those wells in which VOCs detected were within acceptable levels, the Department of Health recommended frequent routine monitoring of the wells for VOCs, but did not recommend discontinuing use of the wells. The MPCA, which is responsible for the investigation of hazardous waste contamination sites, was routinely notified of all confirmed cases of VOC contamination in community wells.

Photo by Buddy Ferguson

According to Dr. Ray Thron, director of the Minnesota Department of Health's Division of Environmental Health, continued sampling of community water supplies is necessary: "A one-time sample just doesn't give a clear overall picture."

For the most part, communities with affected wells were evenly distributed throughout the state, which serves to confirm the initial suspicion that VOC occurrence in groundwater may be widespread.

Survey Results and Remedial Actions

For the most part, communities with affected wells were evenly distributed throughout the state, which serves to confirm the initial suspicion that VOC occurrence in groundwater may be widespread.

The percentage of community water supply systems with detectable VOCs was 8 percent. This result compares favorably to the 21 percent of randomly selected community supplies nationwide found to contain VOCs during the EPA's Groundwater Supply Survey.

Remedial actions were taken in the 15 communities (1.7 percent) in which wells were found to be contaminated in excess of the acceptable drinking water levels. The actions ranged from simply removing a contaminated well from service to providing emergency temporary treatment of contaminated wells.

The Need for Ongoing Sampling

The Department of Health intends to continue monitoring the community wells that were discovered to contain VOCs as a result of the VOC survey. Additionally, community wells that are suspected to be vulnerable to future VOC contamination due to proximity to disposal sites will be monitored on an annual basis.

"A one-time sample just doesn't give a clear overall picture," explains Dr. Ray Thron, director of the Minnesota Department of Health's Division of Environmental Health. "Some communities sampled may have had a plume (or concentration) of groundwater contamination just pass by the sampling site, or sampling may have been done just prior to the arrival of a plume of contamination." He adds that the increasing number of possible leaking underground storage tanks and the identification of additional waste disposal sites emphasize the need for continued sampling.

Minnesota Moves Ahead—and Leads the Way

Dr. Thron explains the trail-blazing nature of the Minnesota survey: "The data generated from Minnesota's VOC study provide encouragement and documentation to assist other states in soliciting funding for the development of similar studies. The results provide valuable data to help assist the EPA both in prioritizing the need to establish maximum contaminant levels for certain chemicals and in establishing future requirements for VOC sampling and analysis."

The Minnesota Department of Health has recently received funding to investigate contamination of groundwater by pesticides in selected community and non-community water supply systems. "In this project," Gary Englund explains, "we're ahead of the EPA. In fact, the Minnesota Department of Health has applied to the EPA for additional funding to generate data that could serve as the baseline for future EPA studies."

Such pesticide studies have taken place in a few states, but the Minnesota study is unique in that it will be conducted under common agricultural practices, with sampling occurring before and after seasonal applications. "We have no idea what we're going to find," states Dr. Thron, "but we do know that the potential exists for contamination of groundwater by pesticides, because of differing agricultural practices and the varying character of the underlying geology in different parts of the state."

The findings of the VOC survey are providing additional public health protection to the residents of Minnesota who depend upon community groundwater supplies.

The results of the VOC survey by the Minnesota Department of Health will go a long way toward satisfying future regulatory requirements of the EPA. More importantly, the reduction of exposure to contaminants brought about by the findings of the VOC survey is providing additional public health protection to the residents of Minnesota who depend upon community groundwater supplies.

Excerpted in part from *Volatile Organic Survey of Community Water Supplies, A Report to the Legislative Commission on Minnesota Resources*, July 1985, by permission of the Minnesota Department of Health.

Limits for Landfills

by Muriel Morrisette

Garbage and Groundwater: A Tale of the Twin Cities

A Minneapolis-St. Paul plan to ban unprocessed waste from landfills by 1990 signals a new era in waste management—and groundwater protection.

When it comes to creating garbage, Minnesotans are pretty much like everyone else in this country—they make too much of it. The Minneapolis/St. Paul metropolitan area generates nearly 5500 tons of mixed municipal solid waste daily—roughly 5.3 pounds per person per day. (Mixed municipal solid waste consists of paper, food waste, yard waste, glass, metals and other materials.) About two-thirds of the solid waste is generated by households and businesses, and one-third by industry.

The Roman Empire Lives—and Leaches—On

Old abandoned landfills are likely to be a cause of continuing concern, because they generate leachate for a considerable length of time after actual dumping operations have stopped. A landfill used during the era of the Roman Empire, for example, was recently found to still produce leachates.

Ground Water: A Non-Technical Guide, 1982

AMNESTY DAYS

Photo courtesy of Florida Department of Environmental Regulation

One effort to reduce the amount of waste—in this case, hazardous waste—being sent to landfills is proving successful in Florida. Citizens bring household hazardous waste to designated collection sites during "Amnesty Days." In one Miami suburb, people turned in 12 tons of hazardous waste that would otherwise have gone out with the garbage.

Though solid waste collected in the Twin Cities area is commonly disposed of in landfills, the volume of solid waste is increasing and landfill capacity is being rapidly used up. If disposal continues at its present volume, landfill space for 34 million tons of waste will have to be found between now and the year 2000. Since the region's operating landfills presently have capacity for only 9.6 million more tons, as many as 10 new landfills would have to be developed—some before 1990. The cost of even one new landfill could be as much as $20 to $50 million.

"All of the landfills that have operated in the Twin Cities metropolitan area since 1970 are contributing to environmental or potential health problems."

No "Fail-Safe" Landfills

Limited space and high costs are not the only problems posed by landfills. According to the Solid Waste Management Development Guide/Policy Plan of the Metropolitan Council (the regional planning agency for the seven-county metropolitan area), "All of the landfills that have operated in the Twin Cities metropolitan area since 1970 are contributing to environmental or potential health problems. Incidents include contamination of surface water, methane gas migration, and nuisances such as litter, noise and odor. Groundwater contamination has been detected at all sites, with varying degrees of severity."

The Development Guide/Policy Plan further explains that groundwater contamination is of considerable concern, because groundwater supplies two-thirds of the water consumed in the region. Existing landfills designed in the early 1970's do not use state-of-the-art environmental control technology or practices.

Existing landfills, along with closed ones, are believed currently to generate over 60 million gallons of leachate, water that has been contaminated by flowing through the waste. Recent studies indicate that even new, well-designed systems allow at least 15 percent of leachate to escape.

Groundwater contamination that is caused by leachate migration is not only difficult to detect, it is also difficult to control or correct. The problem may last for decades, even after the landfill has been closed.

Finding a Better Way

At the same time that solid waste problems were piling up in the metro area, rapid technological development in resource recovery and renewed interest in recycling suggested that alternative waste management techniques were not only necessary, but possible.

In 1980 the Minnesota Legislature passed the Solid Waste Management Act, increasing the Metropolitan Council's responsibility for solid waste management and charging the Council with providing a long-range plan that would set regional waste management policy and provide schedules for developing waste facilities and activities through the year 2000. A Solid Waste Management Development Guide/Policy Plan, established in March 1985, serves as a mechanism for decision-makers to use in approaching solid waste management in the metropolitan area.

No More Unprocessed Waste

A bold new policy, proposed by the Council's Development Guide/Policy Plan, became law in 1985. On the Council's recommendation, the Legislature passed the following amendment to the Solid Waste Act: "After January 1, 1990, waste disposal facilities located in the metropolitan area may not accept mixed municipal solid waste for disposal unless the waste has been transferred to the disposal facility from a resource recovery facility identified by the Council..." Only the by-products of processing—incinerator ash or unrecyclable materials—will be allowed in landfills.

Essentially, this legislation ends the disposal of unprocessed solid waste in the Twin Cities metropolitan area by 1990.

Essentially, this legislation ends the disposal of unprocessed solid waste in the Twin Cities metropolitan area by 1990. It also signals the start of a regional effort to get alternate methods of solid waste management up and going in time to meet the deadline. The available alternatives include waste reduction and processing methods.

One way to solve the problems of too much waste is to generate less of it. Less packaging and more durable goods are examples of waste reduction; so is backyard composting of yard wastes.

The objectives of solid waste processing are to reduce the volume of waste, to convert the waste to usable form, or to separate materials that can be used. Such processes include recycling, materials recovery, burning and central composting.

A New Strategy for Managing Solid Waste

A combination of these and other alternatives for dealing with solid waste will be combined to develop a management program for the Twin Cities area that is environmentally safe, socially acceptable and economically feasible.

Some hard decisions will have to be made in selecting the best alternatives to the old bury-it-all system. The Legislature provided the incentive when it banned landfills in the metropolitan area. The Metropolitan Council has suggested alternatives and recommended the strategies. It will take the cooperation of citizens, industry and government to meet the challenge.

New Jersey Recycles as Landfills Become "Landfull"

Like Minnesota's Twin Cities, New Jersey has too much garbage and not enough places to put it. New Jersey's response—a statewide recycling program—links the public and private sectors in a unique effort to reduce the need for landfills.

From its humble beginnings as a network of street peddlers who collected scrap from homes and small businesses and sold it to scrap dealers, New Jersey recycling evolved over the years into a system of large scrap companies which bought and sold materials for shipment to other parts of the country and the world. In 1970, New Jersey municipalities and volunteer groups joined these recycling efforts out of concern for their environment.

New Jersey's Waste Disposal Crisis

New Jersey generates 6.2 million tons of municipal solid waste per year, an average of about 17,000 tons per day. Included in this yearly total are 9.6 million gallons of used motor oil and the 35,000 tons of leaves that fall on the state each fall. It should come as no surprise to anyone that the state's landfills are becoming "landfull."

Adding to the problem is New Jersey's dependence on groundwater as a source of potable water for half its population. Of the 622 public water supply systems in New Jersey, 558 obtain most of their supplies from groundwater. Groundwater contamination has occurred in many areas, and leaks from landfills are one of the sources of that contamination.

Recognizing that the state was facing a rapidly accelerating waste disposal crisis and that one way to deal with that crisis was recycling, the New Jersey Legislature enacted the New Jersey Recycling Act in 1981. This act established a five-year program to create and expand local recycling programs, with a goal of recycling 25 percent of the state's municipal waste by 1986. This program was designed to stimulate an expansion of recycling services that, if left up to the private sector and volunteers, would have happened much too slowly.

Gravity Never Sleeps

If there is a Murphy's law of groundwater contamination, it must go something like this: Whatever can get into the groundwater, will.
Any substance left exposed to rain or moisture
on the surface of the ground, or underground, will
probably eventually be picked up and carried to groundwater
through the natural process of recharge.
Gravity never sleeps.

—SAWARA *Waterwords*
Southern Arizona Water Resources Association

Waste Surcharge Provides Incentives and Education

The Office of Recycling, set up under the state's Department of Energy, was given the financial resources to turn a government document into a working operation. Funds for this purpose came from landfill surcharge revenues.

In 1983 this fund, which averages about $4.6 million annually, distributed over $2 million among 241 communities, based on the amount of material each community has recycled. The fund is used to assist counties, cities and nonprofit groups with the program planning and education grants needed to start or expand recycling programs. Another $2 million is available in low-interest loans to encourage the growth of recycling industries.

Since recycling programs do not work without a concerned and educated citizenry and business community, an additional $600,000 is being spent on an extensive educational campaign which includes workshops and seminars as well as billboards, magazine and newspaper ads, bus and train posters and radio announcements.

Progress to Date—and a Look Ahead

Dating from 1970, when only 20 New Jersey municipalities had recycling programs, New Jersey's efforts seem to be a great success. Counties, municipalities and volunteer organizations throughout the state now operate recycling programs. As of 1984, 363 of the state's 567 municipalities had recycling programs, up from 287 the previous year (a 21-percent increase).

New Jersey is more than one-third of the way to its goal of recycling 25 percent of the state's municipal solid wastes. Recognizing that there is still a long way to go, the Office of Recycling, in its October 1984 progress report, *Recycling in the 1980s*, proposes statewide mandatory recycling as a means of speeding up progress toward the goal. An advisory committee set up by the Department of Environmental Protection is developing the specific details of such a proposal for future consideration by the New Jersey Legislature.

New Jersey, as the first state in the nation to enact a comprehensive, statewide recycling program is well on its way to conserving landfill space and protecting its groundwater resources.

Muriel Morrisette is a staff writer for the Freshwater Foundation.

A New Waste Ethic: Innovative Options for Waste Management

Banning unprocessed waste from landfills and recycling waste to conserve landfill space represent two "non-technical" approaches to waste management.

New technologies, both biological and chemical, are developing waste management options that go a step further, by effectively neutralizing or eliminating solid or hazardous waste materials.

- Resource recovery programs, commonly known as "waste-to-energy" programs, are based on the premise that solid waste can be incinerated at high temperatures to produce energy, a process which effectively "recycles" solid waste.
- Chemical stabilization processes can neutralize waste or alter its form for safer storage. One such process can turn liquid toxic waste into dry ash and rock-like materials, which can then be buried in remote, protected landfills. Such chemical processes are a viable alternative for chemicals and materials that cannot be stabilized by incineration.
- Biological degradation processes have been used to treat waste for decades. Recent advances in the field, however, have led to using specific microorganisms to degrade specific pollutants. Microbiological waste management presents advantages over other waste management techniques: it can be more economical, and it totally eliminates the waste in question, rather than just displacing it.

Waste, a necessary by-product of society, is a reality. But limited landfill space is also a reality, as is growing concern regarding the effects of stored waste on the environment. A new perspective of waste is developing. In response to that developing perspective, a combination of alternative waste management options—from landfill limits and recycling efforts to chemical stabilization and biological degradation processes—can help to create the basis for a responsible waste management ethic for the future.

Public Enemy #1: Garbage

A recent statewide study of public attitudes revealed the number one public issue in New Jersey.

Was it crime? Inflation? Air pollution? Or the availability of low-cost energy?

None of the above. The number one public issue in New Jersey is garbage disposal. 87 percent of the people think garbage disposal is a serious problem; 96 percent think it needs immediate attention; 97 percent think it affects the health and safety of the people who live in the state; and 89 percent understand that the state's landfills are running out of room.

The survey was commissioned by the Energy Committee of the New Jersey Alliance for Action, a coalition of business, industry, labor, government, professional and public interest groups. The majority of the people polled support the construction of waste-to-energy resource recovery facilities and expansion of materials recycling programs to meet the state's solid waste disposal needs.

"The findings of this survey are pretty conclusive and can be summed up in a nutshell," said Robert Muilenburg, chairman of the Energy Committee. "90 percent of those polled think that resource recovery plants should be used to incinerate garbage and produce energy as a by-product; 88 percent think resource recovery is safer than landfill dumping; and 93 percent think that more recycling of aluminum cans, newspapers and glass should be required."

According to Ellis Vieser, president of the New Jersey Alliance for Action, "The results of this survey indicate that New Jersey residents are prepared to support a program of resource recovery and expanded recycling. We at the Alliance try to serve as a catalyst, to bring together the various key players to work to take action. We're going to need this kind of broad-based, non-partisan support to set New Jersey's resource recovery program in place as soon as possible."

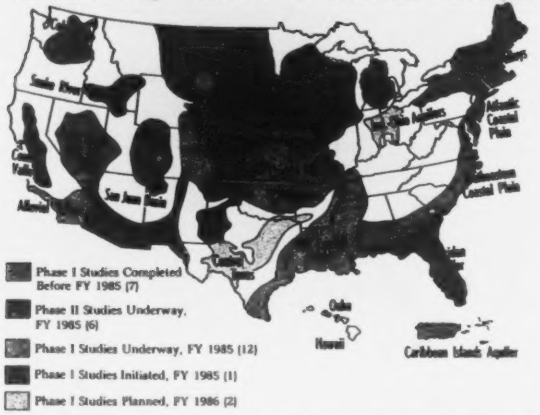
The New Jersey Institute of Technology (NJIT) is working with the Alliance, developing a white paper to identify the type of technology most appropriate to the state's needs. Saul Fenster, NJIT president and member of the Energy Committee, emphasizes: "Nothing is more important to our quality of life—in fact, to our very survival—than finding a safe and affordable way to dispose of our waste."

It appears that the majority of the residents of New Jersey would agree.

Regional Aquifer Studies: A New Perspective

Groundwater: Where does it come from? Where does it go? How much is there? The U.S. Geological Survey is studying groundwater systems on a regional scale, to aid in future regional groundwater management planning.

REGIONAL AQUIFER-SYSTEM ANALYSIS PROGRAM


Snake River
San Juan Basin
Alluvial
Atlantic Coastal Plain
Coastal Plain
Central Texas
Oahu
Hawaii
Caribbean Islands Aquifer
Phase I Studies Completed Before FY 1985 (7)
Phase II Studies Underway, FY 1985 (6)
Phase I Studies Underway, FY 1985 (12)
Phase I Studies Initiated, FY 1985 (1)
Phase I Studies Planned, FY 1986 (2)

The Regional Aquifer System Analysis Program, instituted by the U.S. Geological Survey in 1977, is a systematic effort to study the nation's groundwater systems on a regional scale.

Three Concerns . . .

(1) Groundwater withdrawals from the nation's aquifer systems have been steadily increasing, as have concerns about the quality of groundwater.

(2) Groundwater management is a complex and difficult task, in part because many groundwater-related issues are regional in scope.

(3) The ability to understand groundwater systems and evaluate the impacts of groundwater development is essential to water resource managers.

. . . And a Response

Based on these three related concerns, the U.S. Geological Survey instituted the Regional Aquifer System Analysis (RASA) Program, a systematic effort to study the nation's groundwater systems on a regional scale.

According to Ren Jen Sun, the program's coordinator, "The RASA Program is unique in its regional approach to groundwater analysis. The U.S. Geological Survey is the first agency to look at groundwater from a regional perspective."

An Early Initiative—and an Expanded Focus

The RASA Program was initiated in 1977 as a response to congressional concern over dwindling surface water supplies during the drought of the mid-1970s. Recognizing the inevitability of future droughts and the country's heavy reliance on surface water supplies, the RASA Program was originally designed to look at groundwater as an alternative water supply.

As groundwater use has expanded, so has the RASA Program's original purpose of studying groundwater as an alternative water supply in times of drought. An expanded focus on water quality has led to information being assembled on the quality of water throughout each aquifer system, by bringing together all existing information and collecting field data required to fill any gaps.

According to Dr. David Moody, chief of the U.S. Geological Survey Office of National Water Summary and Long-Range Planning, "The RASA Program is looking at a broad range of aquifer characteristics, including such public health indicators as organics and other wastes."

"As interest has increased over the last 10 years regarding site-specific cases of groundwater contamination, it is fortuitous that the U.S. Geological Survey was already involved in a long-term study of aquifer systems."

While each investigation is designed to fit the particular problems of each study area, all projects will utilize computer models, or simulations, to analyze the hydrologic systems. "Defining the hydrology regionally," stated Mr. Sun, "will establish a framework for assisting state and local groundwater managers with future development decisions." This regional approach will also provide the basis for improved estimation of the effects of regional groundwater patterns on local groundwater supplies. Such information will allow better evaluation of future groundwater management needs.

A Timely Response—and Future Needs

The RASA Program was a timely response to a growing need. Dr. Moody explains: "As interest has increased over the last 10 years regarding site-specific cases of groundwater contamination, it is fortuitous that the U.S. Geological Survey was already involved in a long-term study of aquifer systems." Such a program, he adds, will provide a framework for future aquifer studies.

Future needs will be even greater, though, according to Dr. Moody. "A program of national scope is needed," he explains, "to assess the quantity and quality of both surface water and groundwater. Based on sound scientific data, such a national assessment would better inform Congress and other officials about what is happening to our water resources and why."

The U.S. Geological Survey Regional Aquifer Systems Analysis Program is a bold first step in looking at groundwater systems from a new perspective.

Excerpted in part from "Regional Aquifer Systems of the United States," a U.S. Geological Survey Water Fact Sheet.

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Mr. **Oberstar**. I want to thank this panel and all those who preceded today in providing testimony for the committee. It took a great deal of time and effort to prepare you remarks and to submit your views for the committee. It took a great deal of patience for this last panel to remain so long throughout the day and the afternoon.

We are really being prospective in holding this hearing. We anticipate this will be the first of a series of inquiries into this very, very complex and yet critically important issue of ground water contamination.

All the water there is or ever will be on the face of the earth it here now. Of the 40 trillion gallons of water that pass over the continental United States every day—farmers in the midwest won't believe there is that much, but there is in the upper atmosphere—only about 640 billion gallons a day of that after passage through the atmosphere, after precipitation, runoff, and penetration of ground water is available for use.

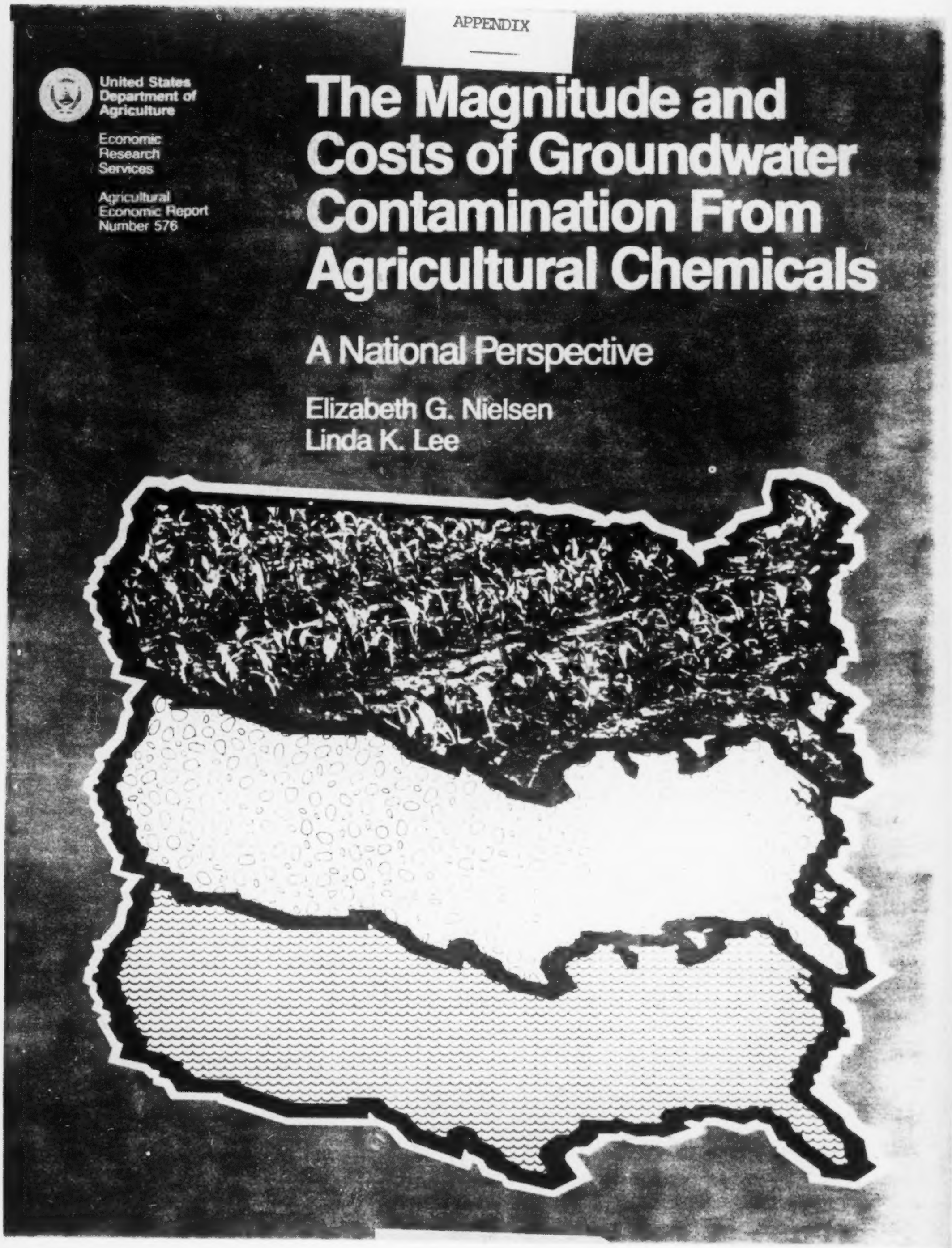
We have developed substitutes for rubber. We have developed substitutes for steel. We have developed sweetener substitutes for sugar. We have not developed a substitute for water. As creative and imaginative as our science has been, there is no substitute for it. So what we have, we have to husband carefully.

That is the purpose of many programs that this full committee has authored and gotten enacted into law and that this subcommittee is privileged to watch over. All of us together must work and bend our best efforts toward preserving that precious resource that Byron once called "endless." We know it is not endless. Only we can protect it. So we must do so. Thank you for your contributions today.

The subcommittee stands adjourned.

[Whereupon, at 3:48 p.m., the subcommittee was adjourned, to reconvene at the call of the Chair.]

APPENDIX



United States Department of Agriculture

Economic Research Services

Agricultural Economic Report Number 576

The Magnitude and Costs of Groundwater Contamination From Agricultural Chemicals

A National Perspective

Elizabeth G. Nielsen
Linda K. Lee

The Magnitude and Costs of Groundwater Contamination From Agricultural Chemicals: A National Perspective. By Elizabeth G. Nielsen and Linda K. Lee. Resources and Technology Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 576.

Abstract

The drinking water of an estimated 50 million people in the United States comes from groundwater that is potentially contaminated from agricultural chemicals. Approximately 19 million of these people get their water from private wells, which are most vulnerable. Findings (based on analysis of synthesized data sources) suggest that potential contamination follows regional trends. Evidence indicates that pesticides and nitrates from fertilizers do not necessarily occur together in potentially affected areas, implying a need to target strategies. First-time monitoring costs range from $0.9 billion to $2.2 billion for households with private wells (mostly in rural areas) and approximate $14 million for communities with community groundwater systems.

Keywords: Groundwater contamination, agricultural chemicals, nitrates, pesticides, drinking water.

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Washington, DC 20005-4788 October 1987

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Summary

The drinking water of an estimated 50 million people in the United States comes from groundwater that is potentially contaminated from agricultural chemicals. Approximately 19 million of these people get their water from private wells, which are most vulnerable. Findings (based on analysis of synthesized data sources) suggest that potential contamination follows regional trends. Evidence indicates that pesticides and nitrates from fertilizers do not necessarily occur together in potentially affected areas, implying a need to target strategies. First-time monitoring costs range from $0.9 billion to $2.2 billion for households with private wells (mostly in rural areas) and approximate $14 million for communities with community groundwater systems.

Because there are no national data on levels of agricultural chemicals in groundwater, this study is a first attempt at synthesizing and analyzing available data sources to indicate which areas are potentially affected. The data do not define local- or county-level contamination potential, but allow an analysis of regional trends. Among the regions with potential pesticide contamination are the Eastern Seaboard, the gulf coast, and the Upper Midwest. Regions having a potential for nitrate contamination include the Great Plains and portions of the Northwest, Southwest, and the Corn Belt. Areas with potential for combined pesticide and nitrate pollution include portions of the Corn Belt, the Lake States, and the Northeast.

In those potentially contaminated regions, an estimated 50 million people rely on groundwater for their drinking needs. Of these people, nearly 19 million obtain their water from private wells. The remainder use public water systems. Private wells are more vulnerable to contamination because they are shallower than regulated public system wells and are often not built as well. Most of the people who rely on groundwater in potentially contaminated areas live where groundwater may contain pesticides or a combination of pesticides and nitrates.

Because monitoring groundwater contamination levels provides information on the need for remedial action, the report analyzes costs of testing for nitrates and pesticides in potentially contaminated areas. Using specific assumptions, researchers estimate that first-time monitoring costs for households with private wells range from $0.9 billion to $2.2 billion, with a "best" estimate of $1.4 billion. Monitoring costs for community groundwater systems are estimated to be much lower, approximately $14 million, because less sampling is required even though the number of people served is larger. As a result, individual well owners, who are often rural residents, will bear the highest monitoring costs.

These findings have important implications for policymakers and water users alike. Farmers, for example, have incentives to reduce contamination if their pesticides and fertilizers are affecting their own well water. Educational programs accompanied by expanded research on the effects of agricultural practices will consequently be important. Different strategies may be implied for different areas since data suggest that pesticides and nitrates from fertilizers are not necessarily found together in groundwater and may impose different costs on society. Finally, not all regions are vulnerable or equally dependent on groundwater. As a result, targeting of strategies will be important.

The Magnitude and Costs of Groundwater Contamination From Agricultural Chemicals: A National Perspective

Elizabeth G. Nielsen and Linda K. Lee[*]

Introduction

The United States relies heavily on groundwater: over 97 percent of rural America's drinking water taps underground sources, 55 percent of the country's livestock water comes from underground supplies, and 40 percent of all water used to irrigate crops is drawn from aquifers. Not only rural America relies heavily on groundwater. In 1980, 40 percent of the population served by public water supplies used groundwater, or nearly 74 million people. Moreover, reliance on groundwater is growing. Between 1950 and 1980, groundwater withdrawals increased 158 percent while surface withdrawals rose only 107 percent (*65*).[1]

Little is known about the scope of most groundwater contamination generated by human activities. The question, however, is critical (*9*). There are documented and suspected risks to human health from exposure to contaminated groundwater (*46*). Because groundwater moves slowly in many areas and some chemicals degrade slowly, contamination can persist for years or even centuries. Cleanup costs can be prohibitive. Moreover, the interaction between surface waters and groundwaters can mean that aquifer contamination ultimately may lead to pollution of streams, lakes, and estuaries in some areas.

Although groundwater contamination has many sources, evidence suggests that agricultural activity may be a significant source. Substantiating that link is a recently published report by the U.S. Office of Technology Assessment that summarizes groundwater contamination and its effects (*69*). The report cites agricultural pesticides and fertilizers as significant groundwater contaminants. The conclusion appears to be supported by documented incidents of contamination attributed to agricultural chemicals in Pennsylvania, Florida, Wisconsin, California, New York, Iowa, and other States (*52, 37, 60, 61, 81, 8, 80, 28, 41*).

The problem is attracting public attention. According to a recent national poll, 80 percent of the U.S. population believes that groundwater pollution is a national problem, and 54 percent of the people think it is a problem in their community. Of those surveyed, nearly 70 percent responded that they believe agricultural fertililizers and pesticides cause water pollution (*7*).

This report assesses the scope and costs of groundwater contamination caused by agricultural fertilizers and pesticides in the United States. While other agricultural activities such as livestock operations may contaminate groundwater in some localities, we focus on crop chemicals because of their broad-scale use across diverse regions of the country.

We combine data from a variety of sources to develop an overview of regions potentially affected by agriculturally induced chemical contamination of groundwater. The report also summarizes the types of damage incurred by agriculturally polluted groundwater along with an appraisal of the costs of preventing potential damages to health and property. The costs of these damages represent the benefits of groundwater protection. The policies and programs now being put into place by several States, including Arizona, California, and Wisconsin, and under discussion by other States and the U.S. Environmental Protection Agency (EPA), require a better understanding of the benefits of groundwater protection. Only when the benefits are well understood can they be compared with the social and agricultural costs of alternative prevention and control measures, leading to the identification of efficient policy options.

---

[*] Elizabeth G. Nielsen is an agricultural economist and Linda K. Lee is a section leader with the Economic Research Service, U.S. Department of Agriculture.

[1] Italicized numbers in parentheses refer to items cited in the References section.

Agriculture and Groundwater Quality

The lack of a consistent and comprehensive data base has made it difficult to establish direct links between human activities and contamination episodes. This is particularly true with respect to diffuse or "nonpoint" pollution sources, which characterize many agricultural activities such as chemical applications. It is clear, however, that several trends over the past 40 years have increased the potential for agriculturally caused groundwater contamination.

The use of inorganic nitrogen fertilizers, a major source of nitrate-nitrogen groundwater contamination, increased fourfold between 1960 and 1980 (fig. 1). A major cause was heavier fertilizer applications, with the per-acre rate doubling between 1965 and 1984. At the same time, the agricultural use of pesticides rose sharply, nearly tripling since 1964 (fig. 2). Figure 3 shows that herbicides accounted for most of the increase. They constituted 82 percent of all pesticide use on major field and forage crops in 1982 (*72*).

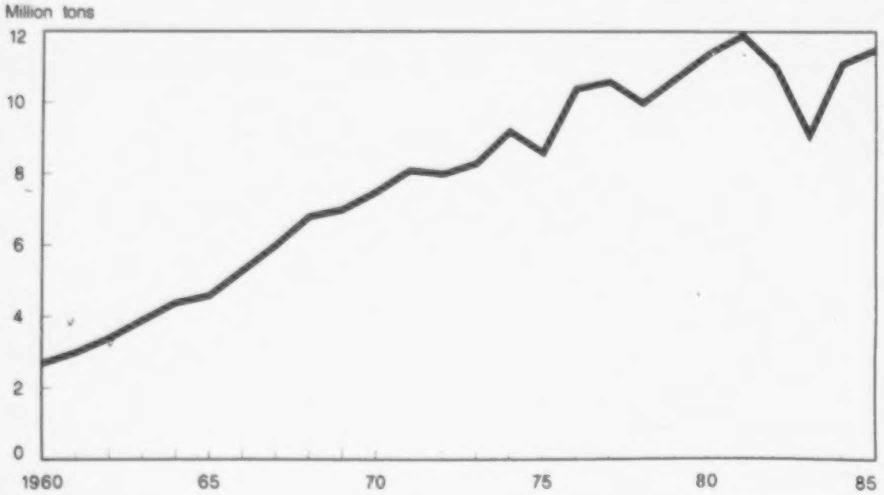
Other trends increased the potential for contamination from both diffuse and concentrated "point" sources, at least in some locations. Wastes generated in concentrated livestock, dairy, and poultry operations have stretched the land's waste assimilative capacity and created a potential for nitrate contamination, particularly in areas where commercial fertilizers are also applied. This situation is particularly critical where the nitrogen content of animal manure the land receives is underestimated or ignored.

Cultivation practices may also contribute. An increase in conservation tillage, for instance, may imply an increase in both pesticide and fertilizer contamination of groundwater through increased water infiltration and reduced runoff, although the relationships are not well understood and may vary from one area to another (*19, 20, 31*). Expanding the amount of irrigated land over the years also may have contributed to groundwater contamination. Irrigation can increase the concentration of salts, pesticides, and fertilizers in groundwater recharge, as well as in irrigation return flows (*31, 39, 64*).

The potential for groundwater contamination, as well as the magnitude, extent, and duration of contamination, depend not only on land uses and agricultural practices, but also on climate, hydrogeology, and other conditions. These include soil characteristics, net aquifer recharge rate, depth to the water table, and characteristics of the unsaturated zone and the aquifer.

Figure 1

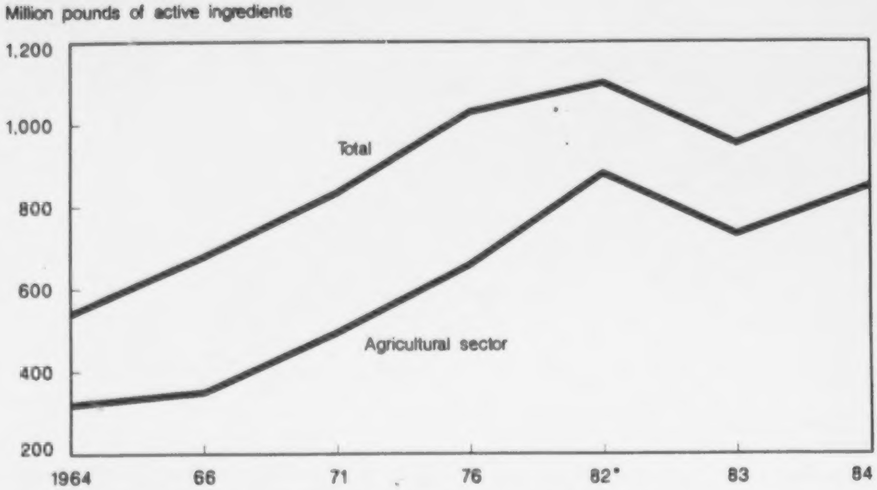
Trends in U.S. Agricultural Nitrogen Use, 1960-85



Sources: (*70, 71, 73*)

Figure 2

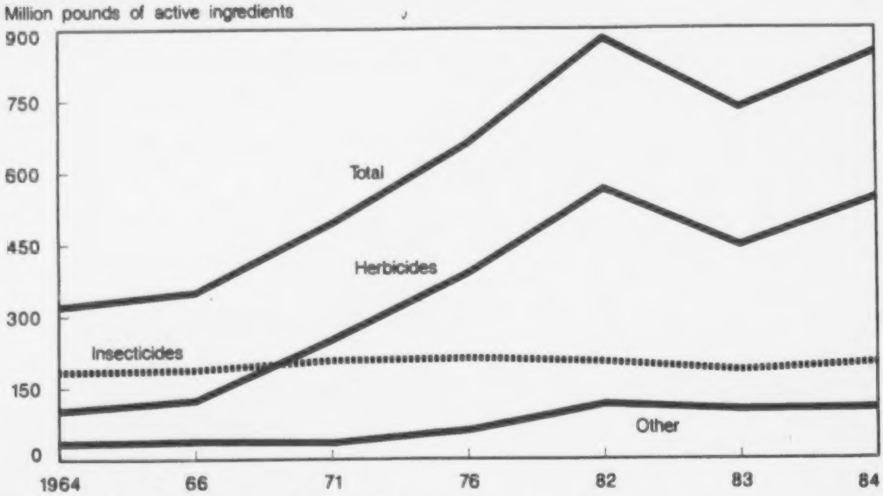
U.S. Pesticide Use, 1964–84



Source: Estimates from the U.S. Environmental Protection Agency (EPA), Office of Pesticide Programs, Economic Analysis Branch.
Note: Pesticides exclude wood preservatives, disinfectants, and sulfur. * Revised 1982 numbers.

Figure 3

Trends in Agricultural Pesticide Use by Class, 1964–84



Source: Estimates from the U.S. Environmental Protection Agency (EPA), Office of Pesticide Programs, Economic Analysis Branch.

The characteristics of a potential pollutant, such as water solubility, adsorption, and persistence, strongly affect its ultimate fate. In addition to increased pesticide and fertilizer use, changes in the types of pesticides applied (that is, generally less persistent, but less likely to attach to soil particles)[2] may mean a greater likelihood of contamination. Pesticides that are less adsorbent and more soluble in water have more potential to move out of the root zone toward groundwater particularly when recharge rates are high.[3] The method and timing of chemical applications, in addition to tillage and irrigation practices, also affect the likelihood that a chemical will move to groundwater. Also, accidents, leaks, and improper chemical disposal practices can lead to local point-source contamination episodes.

Predicting groundwater contamination clearly requires consideration of diverse factors which interplay in the process. Our data reflect the interaction of farming activities with physical vulnerability to aquifer contamination from pesticides and nitrogen fertilizers. We combine these to evaluate the potential for regional groundwater contamination.

Potential Groundwater Contamination From Agricultural Sources

To estimate the areas in the United States potentially at risk to groundwater contamination from pesticides and fertilizers, we defined areas of potential contamination by using data on actual levels of contaminants in groundwater, where the data were available.[4] If data were unavailable, potential contamination was defined by synthesizing information on physical vulnerability to contamination with data on chemical use. In both cases, the population in areas of potential contamination is assumed to face a greater risk from agricultural chemicals in groundwater than the population in other regions. Because the costs associated with these risks largely depend on the population potentially exposed, we also made projections of the numbers and distribution of people using groundwater in potentially contaminated areas.

We based potentially contaminated areas on a synthesis of several data sources. Although each source has limitations which, taken together, lessen the sensitivity of localized analysis, we believe the regional trends depicted from the combined data sources reflect the best available information.

Pesticides

Because no national data base on pesticide levels in groundwater exists, we developed a method to simulate areas potentially affected by pesticides in groundwater resulting from agricultural chemical applications.

Approach and Data Sources. To simulate potential contamination, we synthesized two data sources. The first was the U.S. county-level "Pesticide DRASTIC" assessment (*2*). DRASTIC is an index that allows analysts to rate an area's relative vulnerability to groundwater contamination based on the area's hydrogeologic characteristics. These characteristics form the basis for the acronym DRASTIC (D = depth to the water table; R = net recharge; A = aquifer media; S = soil media; T = topography; I = impact of the vadose zone; C = hydraulic conductivity). The Pesticide DRASTIC index is a version of DRASTIC designed specifically to assess vulnerability to contamination from pesticide use. The second source was a data base on county-level pesticide use developed by an independent research organization, Resources for the Future (RFF).[5]

To focus on potential problem pesticides, we limited our analysis to those chemicals recommended for inclusion in EPA's national survey of pesticides in well water (termed by EPA priority A and B categories). Of the 45 chemicals, we eliminated 7. Three (EDB, DBCP, and 1, 2-dichloropropane) were not represented in the RFF file because EPA had banned them. Another four (tebuthiuron, prometone, propoxur, and pentachlor) were listed in the file but showed no agricultural uses. Table 1 lists the 38 pesticides used in our analysis along with information on the type and amount of use, the number of States in which each chemical has been found in groundwater, and other facts pertinent to EPA's classification of these chemicals as high-priority pesticides. These pesticides, which are primarily herbicides, represent 60 percent of all agricultural pesticide applications accounted for in the RFF file.

Because voids exist in the current data and since so little is known about how groundwater becomes contaminated, the process of identifying which pesticides are potential groundwater contaminants is a subjective one. In the absence of a definitively superior selection method, we chose to use the chemicals EPA has classified for its national water well survey as Priority A (recommended for inclusion) and Priority B (recommended, but subject to negotiation if the laboratory analytical method is difficult or unavailable).[6]

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[2] In 1982, over half of all herbicide use on major field and forage crops was accounted for by four chemicals—alachlor, atrazine, butylate, and metolachlor (*72*)—all of which have a moderate to high potential to leach.

[3] See (*16*), (*32*), (*39*), and (*54*) for discussions of chemical characteristics and other factors which affect contamination potential.

[4] Alaska and Hawaii were not included in the analysis because the data sources used were not consistently available for these States.

[5] The Appendix describes both the DRASTIC index and the RFF data base in more detail.

[6] A series of internal memoranda describes the year-long selection process undertaken by EPA (*10*, *11*, *12*, and *13*). That information is available from the authors upon request.

Table 1—Pesticides included in the analysis[1]

Pesticide	Type[2]	Estimated use[3]	States in which pesticide is found in groundwater	EPA description
		Thousand lbs.	*Number*	
Acifluorfen	H	1,399	0	Leacher
Alachlor	H	85,015	4	Leacher
Aldicarb	I,N	2,271	15	Mobile; marginal persistence
Ametryn	H	96	0	Leacher
Atrazine	H	77,316	5	Leacher
Bentazon	H	8,410	0	Leacher; toxicological concern
Bromacil	H	1,234	1	Leacher
Butylate	H	55,095	0	Mobile; uncertain persistence; toxicological concern
Carbofuran	I,A,N	7,695	3	Leacher
Chloramben	H	6,069	0	Leacher
Chlordane	I	11	0	Persistent; possible direct contamination via termiticide use
Cyanazine	H	21,626	2	Leacher
Cycloate	H	52	0	Mobile; uncertain persistence; toxicological concern
Dalapon	H	261	0	Leacher
Dacthal/DCPA	H	196	1	Leacher
Dicamba	H	4,158	0	Leacher
2,4-D	H	37,217	0	Marginal leacher, heavy use
Dinoseb	H	8,835	1	Leacher
Diphenamid	H	598	0	Marginal leacher; toxicological data gaps
Disulfoton	I,A	2,105	0	Leacher
Diuron	H	1,861	0	Leacher
Fenamiphos	I,N	348	0	Moderate leacher; toxicological concern
Fluometuron	H	2,943	0	Leacher
Hexazinone	H	11	0	Leacher
Maleic Hydrazide	H	287	0	Leacher; toxicological data gaps
MCPA	H	9,861	*	Marginal leacher; possible occurrence in groundwater
Methomyl	I	425	0	Leacher
Metolachlor	H	37,940	2	Leacher
Metribuzin	H	10,603	1	Leacher
Oxamyl	I,A,N	51	2	Leacher
Picloram	H	549	0	Leacher
Pronamide	H	83	0	Leacher
Propazine	H	1,287	0	Leacher
Propham	H	445	0	Leacher
Simazine	H	3,975	3	Leacher
2,4,5-T	H	204	0	Marginal leacher
2,4,5-TP	H	7	0	Marginal leacher
Terbacil	H	833	0	Leacher

* indicates possible occurrence in groundwater.

[1] Included pesticides are those in high-priority categories for EPA's national survey of pesticides in well water. Other methods of identifying potential groundwater contaminants might produce different results.

[2] A = acaricide; H = herbicide; I = insecticide; N = nematicide.

[3] Thousands of pounds of active ingredient per year used for agricultural purposes only.

Sources: *(10, 13, 14, 59)*.

Groundwater Quality Terms

Adsorption—Adherence of molecules to the surface of the solids or liquids with which they are in contact.

Aquifer—A water-bearing geological formation.

Groundwater—Water that is found in the saturated zone.

Hydraulic conductivity—A measure of the ease with which a fluid will pass through a porous earth material.

Leaching—Passing through or out of by percolation. Agricultural chemicals leach when they move downward beyond the root zone with the flow of water. Chemical and environmental factors affect leaching.

Nonpoint source contamination—Pollution from broad areas, such as areas in which fertilizers have been applied, rather than from concentrated discharge points.

Persistence—A substance's "lasting power" or stability, usually measured in half-life, or the time it takes for one half of the substance to be degraded or transformed.

Point-source contamination—Pollution originating from a distinct source, such as the outflow from a pipe or concentrated animal production facilities.

Recharge (net)—The amount of water per unit of land that penetrates the ground surface and reaches the water table.

Root zone—The area of the unsaturated zone from which plant roots draw water and nutrients. Its thickness depends on the plant, soil, and climate.

Saturated zone—The subsurface area in which all the pore spaces in the rock or soil materials are filled with water.

Soil media—The uppermost portion of the unsaturated zone that has significant biological activity.

Unsaturated (vadose) zone—A geological subsurface area located above the water table.

Volatility—The loss of a compound to the atmosphere.

Water solubility—The amount (mass) of a substance that will dissolve in water under specific conditions.

Water table—The top of the saturated zone.

The 38 high-priority pesticides we used are described by EPA as potential "leachers," which means they have a high probability of moving to groundwater. Note, however, that the 38 included pesticides vary in terms of volatility, persistence, and the other basic characteristics of pesticides that affect leaching probability. Each pesticide could behave differently under alternative climatic and agronomic conditions. However, we assigned them equal weights in our analysis so that each pound of active ingredient was assumed to contribute equally to the contamination potential, no matter what the pesticide. Equal weights were necessary because there is now no method available to accurately rate or rank pesticides according to their leaching potential.

We translated the total county-level pesticide use estimates into average per-acre applications, using cropland acres from the *Census of Agriculture*.[7] These ranged from 0 to 3.4 pounds of active ingredient per acre, with an average of 1.0 pound. We grouped them into high (greater than 1.2), medium (0.5 to 1.2), and low (less than 0.5) categories.[8] We similarly grouped the pesticide DRASTIC scores, which had a maximum of 245 and averaged 133, into high (greater than 147), medium (107–147), and low (less than 107) categories. Using the hypothesis that the combined hydrogeologic and pesticide use factors provide more information on contamination potential than do either of the separate indexes, we then calculated three combinations of the high and medium categories for the two variables of per-acre applications and DRASTIC scores. Although the distinctions among the categories may be imprecise, particularly between the high pesticides/medium DRASTIC and the medium pesticides/high DRASTIC categories, we plotted all categories separately to give the reader added information on the factors that have caused areas to be identified as "potentially contaminated."

Results. Figure 4 shows which areas fall into the categories of "potentially contaminated." Three hundred and sixty-one counties fall into both the high DRASTIC score and high pesticide use categories. The remaining areas highlighted by figure 4 have either a high DRASTIC score and medium pesticide applications or the reverse combination. In total, 1,128 counties are represented in figure 4, or roughly one-third of the counties in the conterminous States.

The southern Coastal Plain (including Florida), the central Atlantic region, the Mississippi Delta, the northern Corn Belt, western Kentucky, and the central valleys of California are the major regions that have high pesticide contamination potential. Other smaller areas in the Northeast, Texas, and Idaho also have potential contamination.

The regions depicted in figure 4 as having potential groundwater contamination from pesticides correspond with production of pesticide-intensive crops such as corn and soybeans. Tobacco, cotton, rice, and peanut production in the Southeast also show high pesticide use as do fruit- and vegetable-producing areas in Florida, California, and portions of the Northeast and Lake States.

Although figure 4 is not based on actual levels of contaminants in groundwater, the data generally correspond to verified incidents of groundwater contamination from normal agricultural pesticide use. Figure 5 pinpoints actual contamination incidents as of mid-1986. Seventeen pesticides have been found in the groundwater of 23 States, with most located along the Eastern Seaboard, in the Midwest, and in some agricultural areas of the West. Because the data shown in figure 5 do not represent a random sample and because sampling incidence, frequency, and patterns vary dramatically from State to State, the data are best considered the lower bound on actual instances of groundwater contamination.

Data Limitations. The maps should not be used to single out individual counties, but rather should be viewed with regional trends in mind because of data limitations. For example, because DRASTIC data are averaged across counties, they mask factors that could point to contamination vulnerability at the subcounty level. Similarly, aggregating county-level pesticide use allows data on crops with high rates of pesticide applications to be averaged in with data on applications to less pesticide-intensive crops grown in the same county. On the other hand, moderate to high pesticide use may put the entire county "on the map" even if the high-application area represents a small percentage of the total county land area.

When one or a small group of counties stands alone, as some do in figure 4, there are several possible explanations. First, the area actually may be more vulnerable than surrounding areas because of its sensitive local hydrogeologic conditions, the production of pesticide-intensive specialty crops, or both. Second, some counties may be quite similiar to surrounding counties but slightly exceed or fall short of cutoff points for pesticide use or for DRASTIC. Idaho's Lincoln and Minnedoka counties, which are located within an intensively cropped area with medium DRASTIC scores, appear to slightly exceed the high DRASTIC cutoff point. The counties on the northern Missouri border, however, just fail to meet the high pesticide use cutoff, and thus do not appear on the map, even though their DRASTIC scores are similar to

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[7] In counties where sugarcane is grown (in south Florida and Louisiana), sugarcane acreages were first subtracted from the cropland acres reported in the *Census of Agriculture*. This was done to compensate for the fact that pesticide applications on sugarcane are not included in the RFF file. Thus, the average application rate estimates for these counties represent crops other than sugarcane.

[8] We determined ranges by identifying patterns in the distribution of the variable for all U.S. counties.

Figure 4

Potential Groundwater Contamination from Pesticide Use

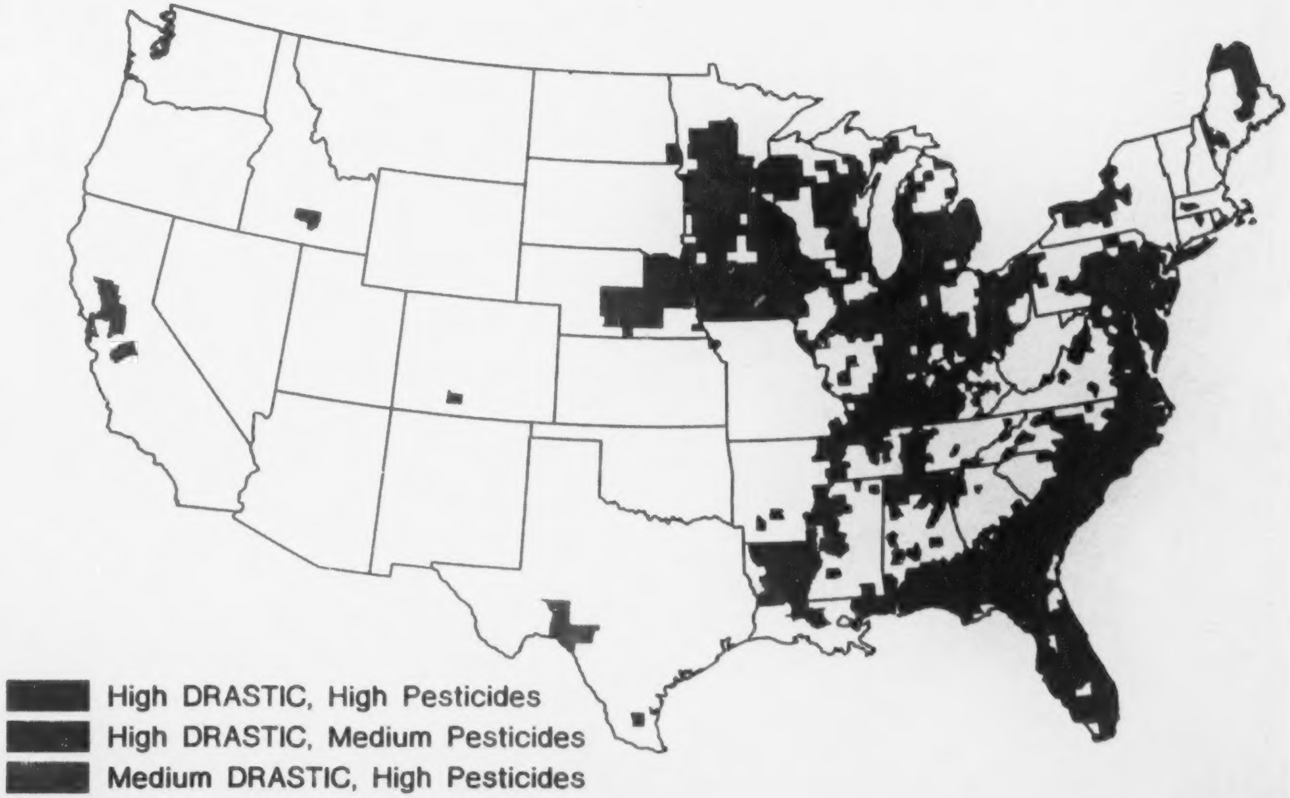
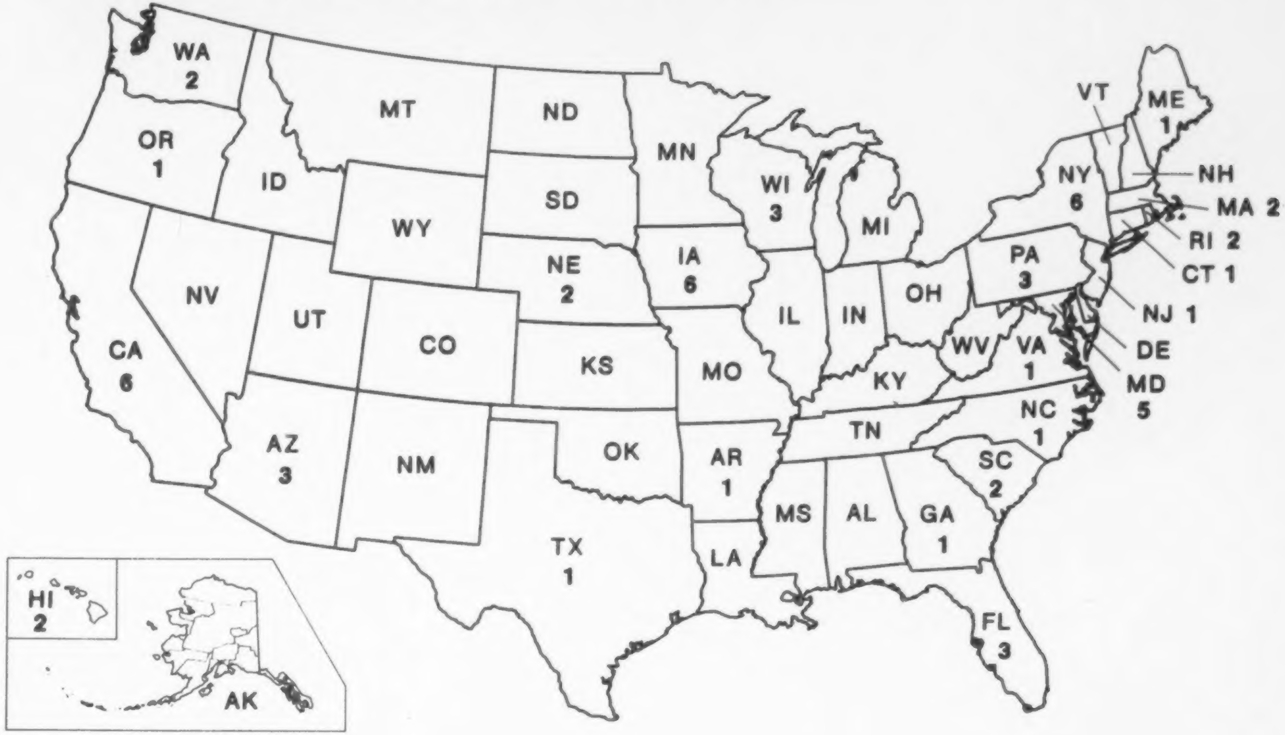

High DRASTIC, High Pesticides
High DRASTIC, Medium Pesticides
Medium DRASTIC, High Pesticides

Figure 5

Numbers of Pesticides Found in Groundwater Caused by Agricultural Practices, 1986


WA
2
OR
1
CA
6
ID
NV
MT
WY
UT
AZ
3
CO
NM
ND
SD
NE
2
KS
OK
TX
1
MN
IA
6
MO
AR
1
LA
WI
3
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
1
PA
3
VA
1
NC
1
SC
2
FL
3
NY
6
VT
ME
1
NH
MA 2
RI 2
CT 1
NJ 1
DE
MD
5
HI
2
AK

Source: (14)

scores in southern Iowa. Finally, an isolated county may appear on the map because of bias in the data bases, and may not be a true indicator of either a county or a regional vulnerability trend.

Biases may be introduced from several sources. First, averaging may introduce bias. Both data bases we used yield average values which may be highly variable. For example, hydraulic conductivities vary greatly over small geographic areas, yet an average value is used. Second, bias can originate from measurement errors and inconsistencies in the DRASTIC data base, although these are largely unknown because comparisons with simulations or field data have not been conducted. However, the DRASTIC distribution generally corresponds with known hydrogeologic conditions (*2*). Finally, extrapolation techniques can introduce some distortions to estimates of regional crop pesticide use. Applying the coefficients derived from California's pesticide use on vegetables to all other States that grow these crops may be the most significant source of bias.[9] We considered the alternative of implicitly assuming no pesticide applications in areas with poor data to be less attractive, however. In a similar way, distortion can be caused by applying State or regional coefficients to all counties within the area, thereby masking cross-county variations.

Nitrates

We estimated areas of potential contamination from nitrogen fertilizer use by synthesizing three data sources.

Approach and Data Sources. The primary data source we used for the analysis was the U.S. Geological Survey (USGS) National Water-Data Storage and Retrieval system (WATSTORE), which contains nitrate levels in samples collected over the past 25 years from 87,000 wells throughout the country. To that data base, USGS added statistical information on 36,000 wells obtained from the Texas Natural Resources Information System of the Texas Department of Water Resources. Because regional gaps exist in the USGS file, we supplemented the USGS data with a proxy for contamination developed from DRASTIC and fertilizer use data.

Starting with the USGS data, we used multiple criteria (based on metropolitan status and percent of county in cropland) to exclude from the analysis areas which have little or no agriculture. The exclusions were made to minimize the possibility that high nitrate levels caused by urban sources, such as septic tanks, would be attributed to agriculture. Thus, 753 counties, or one-fourth of the total, were eliminated. Counties with fewer than five wells sampled (661 counties) were also omitted from the analysis because of insufficient information. We analyzed the 1,663 counties remaining in the data base for nitrate levels recorded in their groundwater. Well data were analyzed according to the following categories of nitrate-nitrogen levels:

0-3 mg/L (milligrams per liter) –	Assumed to represent natural background levels, with minimal human influence.
3.1-10 mg/L –	May indicate elevated concentrations resulting from human activities.
More than 10 mg/L –	Exceeds maximum concentration in EPA's National Interim Primary Drinking-Water Regulations.

We developed a contamination proxy to supplement the USGS data for those 661 counties with insufficient data. In an approach resembling the analysis of pesticide pollution potential described earlier, we combined DRASTIC index county ratings with nationally available estimates of nitrogen fertilizer applications for five crops: corn, cotton, soybeans, sorghum, and wheat.[10]

The proxy is a rough measure of excess nitrogen applied (amount added minus amount needed). Although the link between excessive nitrogen applications and nitrates in groundwater has been established[11], there are other important influences which cannot be accounted for by nitrogen use or DRASTIC data. These influences, which include irrigation practices, natural nitrate-bearing deposits, and natural vegetation, help to explain the results of the analysis, and are discussed later in the report.

We summed the county-level estimates of pounds of nitrogen fertilizer applied per acre across crops and distributed totals into high (greater than 103), medium (52-103), and low (less than 52) categories. Counties at the higher end of the scale tend to be those that grow corn or cotton, or rotate corn and soybeans. As a single crop, soybeans typically fall into the lower levels. Wheat falls into the medium range. Application rates and percentages of acres treated vary widely across States for the same crop, however.

The regular DRASTIC scores were generally lower than the pesticide DRASTIC scores, averaging 109 nationally and ranging from 48 to 214. We grouped these into three categories: high (greater than 121), medium (89-121) and low (less than 89). Combinations of high and medium categories were identified and mapped.

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[9] An alternative data base on pesticide use is available, based on survey information from Doane Marketing Research, Inc. While it avoids the problem of cross-regional extrapolation, it omits numerous crops. Since some of these crops, particularly vegetables, are often grown in areas vulnerable to contamination and are typically treated heavily with pesticides, we used the RFF data base for our analysis.

[10] At the recommendation of a developer of the DRASTIC index, we used the regular DRASTIC index ratings rather than the pesticide DRASTIC ratings for the nitrate assessment (*3*).

[11] See, for example, (*27*), (*52*), and (*53*).

Results. The USGS data indicate that of the 1,663 counties analyzed, there were 474 in which 25 percent or more of sampled wells had nitrate-nitrogen levels exceeding 3 mg/L (fig. 6). Counties in which 25 percent or more of wells exceed 10 mg/L are a subset of these and total 87. Figure 6 also maps those 661 counties with insufficient data for which the DRASTIC and nitrogen fertilizer use scores are computed and presented later. Nonshaded areas represent both the 751 counties excluded from the analysis and the 1,189 counties which met the criteria for analysis but in which fewer than 25 percent of sampled wells exceeded 3 mg/L of nitrate-nitrogen.

According to these data, groundwater contamination from nitrate-nitrogen appears to be concentrated in the Central Great Plains; the Palouse and Columbia Basin in Washington; portions of Montana; southwest Arizona; the irrigated fruit-, vegetable-, and cotton-growing areas of California; portions of the Corn Belt; southeast Pennsylvania; and parts of Maryland and Delaware. Within these regions, Kansas, west Texas, and southern Arizona have the highest recorded concentrations, with 25 percent or more of sampled wells having nitrate-nitrogen levels exceeding 10 mg/L.

Some areas highlighted in figure 6 represent a combination of fertilizer applications and irrigation, particularly in California, the Columbia Basin in Washington, northern Texas, and portions of Kansas and Oklahoma. However, not all areas with this combination appear as problem areas in figure 6. Florida is an important example.

A major source of the high recorded levels in areas such as the Great Plains and the Southwest may be naturally occurring accumulations. Available information is inadequate to separate the natural from the human influences, however. It is important to note, though, that human influences such as cultivation or irrigation can cause previously stationary natural nitrate deposits to leach to groundwater (*44*).

Numerous studies focusing on specific locations have confirmed the high nitrate levels shown in figure 6 and, in some cases, have linked these elevated levels to agricultural activities. Examples include Long Island, New York, and sections of Illinois, Nebraska, Iowa, Pennsylvania, California, and Wisconsin (*1, 5, 25, 28, 52, 58, 62*).

Figure 7 shows the outcome of the analysis based on nitrogen application and DRASTIC scores. Counties combining medium DRASTIC and high nitrogen applications make up the majority of the 441 counties shown on the map. The 441 counties are situated primarily in the Corn Belt, eastern Pennsylvania, and California. Other areas identified as having potential contamination by these criteria are in Washington, Texas, Oklahoma, Georgia, North Carolina, and the Chesapeake Bay area.

Although figures 6 and 7 have many similarities, they do not closely correspond. In particular, figure 7 does not indicate the potential for elevated concentrations of nitrate-nitrogen in groundwater in the Great Plains States although figure 6 shows that they have high levels. The reason may be that the method used to generate figure 7 does not account for some agricultural and nonagricultural factors influencing nitrate levels, such as natural nitrate-nitrogen concentrations, livestock operations, differential crop uptakes, and fallowing effects.

Another lack of correspondence may be traced to hydrogeology and normal biological action. The investigation based on the combination of nitrogen applications to the soil and DRASTIC analysis predicts nitrate levels for Georgia's and eastern North Carolina's groundwater. This prediction is not borne out by the data displayed in figure 6, however. Eastern North Carolina and Georgia have high water tables, which may cause excess nitrate-nitrogen to be lost by denitrification or biological uptake by riparian vegetation (*35, 36*). Furthermore, in areas where the rate of groundwater flow is high and/or where a clay layer underlies the topsoil, nitrate-laden groundwater may be flushed to surface waters fairly quickly (*79*).

Despite these limitations, we felt that the high levels of nitrogen fertilizer use in the areas such as the Corn Belt where USGS data were insufficient warranted an attempt to estimate the groundwater's potential for nitrate contamination from fertilizer, and we used DRASTIC and fertilizer use data only in areas where USGS data were poor. Some information suggests that the analysis based on nitrogen use and DRASTIC data may reflect trends in the Corn Belt. For example, one of the Corn Belt States in which nitrates in groundwater are predicted by the nitrogen use/DRASTIC analysis but for which there is insufficient USGS monitoring data is Illinois. Several studies have found a statistical relationship between fertilizer use and nitrate levels in groundwater in certain parts of that State (*1, 42*). Similar results have been found in Iowa (*27*). Because the Corn Belt States are in general hydrogeologically similar (*30*), these studies might indicate larger regional trends, although the data are unavailable to test such a hypothesis.

We synthesized the two data analyses on potential nitrate contamination by supplementing the USGS data base with information from the nitrogen applications/DRASTIC analysis. The 474 counties in which 25 percent or more of sampled wells exceeded 3 mg/L were identified as having elevated nitrate-nitrogen concentrations in groundwater due mainly to nitrogen fertilizer use. Those 661 counties with insufficient data shown in figure 6 were supplemented with information from the 441 counties identified through the analysis based on nitrogen applications and DRASTIC scores shown in figure 7. (Any identified county in figure 7 corresponding to a county with insufficient information in figure 6 became an additional county labeled as having poten-

Figure 6

Nitrate-Nitrogen Distribution in Groundwater in Agricultural Areas

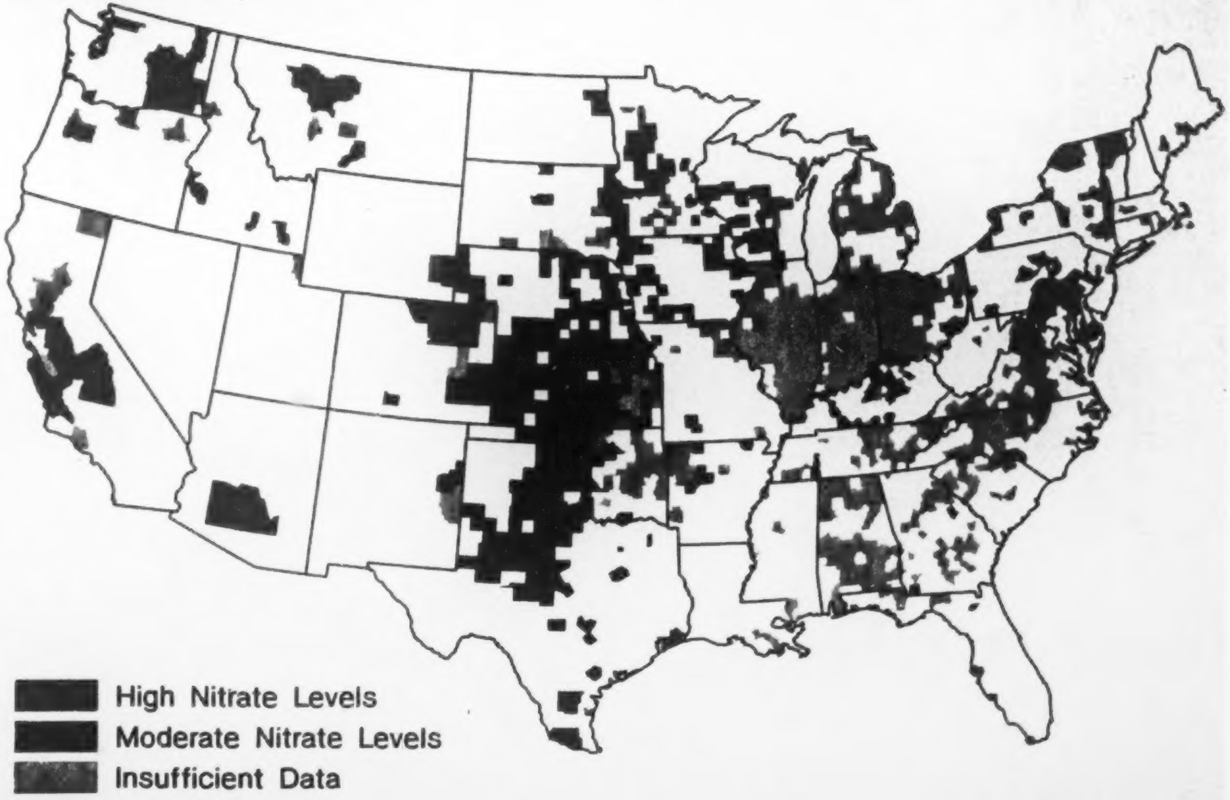
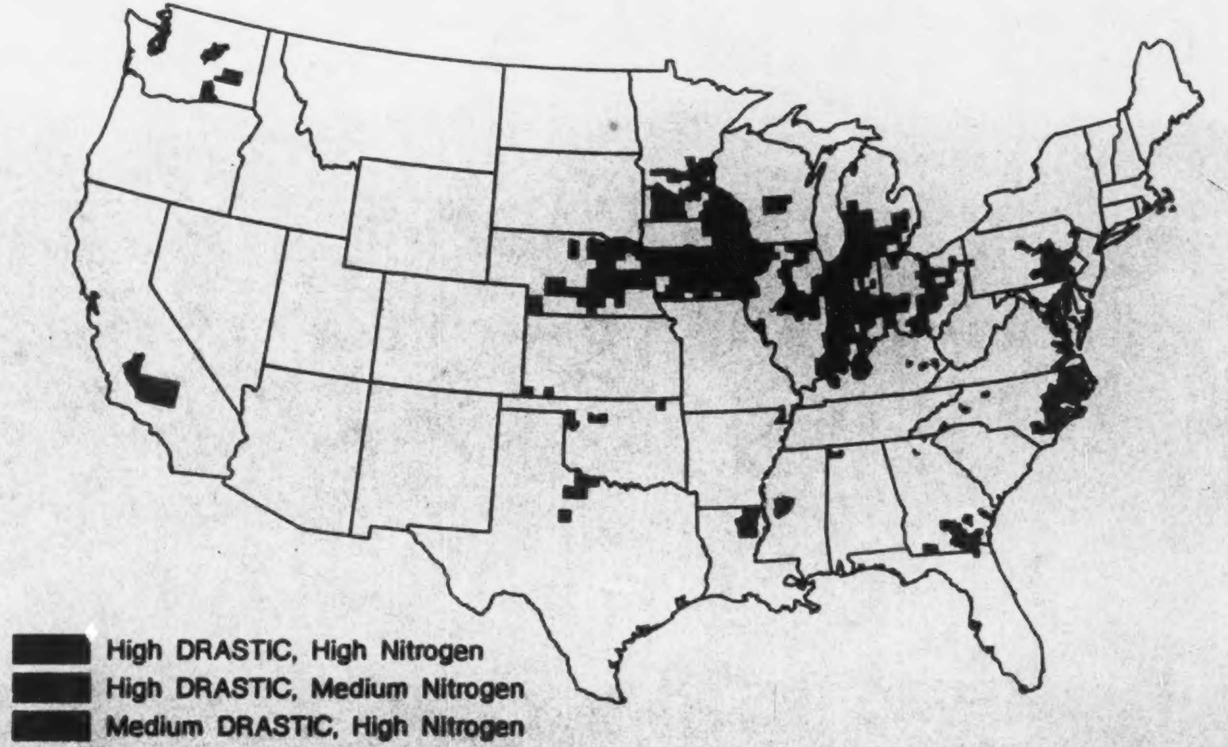

High Nitrate Levels
Moderate Nitrate Levels
Insufficient Data

Figure 7

Combinations of Nitrogen Fertilizer Use and DRASTIC Ratings[1]


■ High DRASTIC, High Nitrogen
■ High DRASTIC, Medium Nitrogen
■ Medium DRASTIC, High Nitrogen

1/ Fertilizer use data include five crops: corn, wheat, soybeans, cotton, and sorghum.

tial nitrate problems.) The matching process identified 149 counties (principally in the Midwest) which, when added to the 474 counties in the USGS data base, produced a total of 623 counties with nitrate-nitrogen in groundwater attributed chiefly to large nitrogen fertilizer applications.

Figure 8 maps the combined analysis. The first two categories, high and medium nitrate levels in groundwater, correspond to the first two categories in figure 6. The third category, vulnerable areas with insufficient USGS data, represents those 149 counties identified by the nitrogen use/DRASTIC analysis as potentially contaminated.

Data Limitations. The USGS data represented by figures 6 and 8 do not represent a random sample of all U.S. wells or aquifers because the types of wells sampled, the numbers of wells, the time period covered, and the areal coverage of sampling networks differ from State to State and within States (*44*). For example, the data from one county grouped in a high category may represent only observations from shallow wells in areas of suspected contamination while another county's data may reflect a more areally representative sample. Little information was available for portions of some States because data were not in a machine-readable form or there had been limited data collection and analysis efforts (*44*).

Nonagricultural influences cannot be completely eliminated, nor can those of natural background levels of nitrate-nitrogen and atmospheric deposition. All are unquantified and vary widely from one location to another. Moreover, agricultural influences independent of fertilization might be reflected in the data. For instance, intensive livestock operations such as dairy farming carried out in portions of Pennsylvania, New York, and Wisconsin, and feedlot operations in such areas as Texas and parts of the Southeast, may have influenced the data. We expect these influences to be primarily local, however.

Because the nitrogen fertilizer application data used to supplement the USGS analysis reflected in figure 7 are limited to five crops in major producing areas, the data underestimate national commercial nitrogen fertilizer use. Since data on nitrogen fertilizers were used only as supplements to observed nitrate contamination levels in groundwater, however, the effect of this shortcoming is minimal. The Corn Belt and the Southeast are the major regions with missing USGS data. These are the regions for which it was possible to employ the supplemental nitrogen use/DRASTIC index analysis because they primarily grow the crops for which nitrogen fertilizer estimates are available.

Nitrogen application rates, as noted above, only roughly approximate excess nitrogen applied. Very high rates may not be excessive due to very high yields or the nature of the agronomic system. Low application rates may be excessive if yields or plant nitrogen requirements are very low.

Furthermore, aggregated nitrogen application data, like the pesticide application data, were extrapolated to the county level based on crop acreages. As a result, individual counties may actually receive applications significantly different from Statewide averages. Finally, the reader should note that the extent to which the DRASTIC index is appropriate for predicting potential contamination from nitrates is open to question because of the complexity of the factors and processes determining their fate. However, we believe the nitrogen use/DRASTIC index can provide useful supplemental data in some regions.

Areas Potentially Affected

Together, areas with potential groundwater contamination from pesticide and/or fertilizer use account for 1,437 counties, or about 46 percent of the counties in the conterminous States. Figure 9 shows evidence of regional trends. Counties with only potential pesticide contamination total 814, and are located largely along the Eastern Seaboard, gulf coast, and the Upper Midwest. Counties with only potential nitrate contamination total 309, and are located principally in the Great Plains and portions of the Northwest and Southwest. Only 314 counties, or less than one-fourth of those identified as having potential contamination from agricultural chemicals, show both high pesticide and nitrate contamination potential. These are located chiefly in parts of the Corn Belt, the Lake States, and the Northeast.

These 1,437 counties with pesticide and/or nitrate contamination potential are cropped intensively, with 33 percent of all land area in crops compared with 16 percent nationwide. About 70 percent of the crop acreage in the sample is devoted to corn, wheat, and soybeans. Though strongly agricultural, these counties are heavily populated, with 27 percent of the land but 47 percent of the population.

Population Potentially Affected

People who live where the groundwater contamination potential from agriculture is high and consume mostly groundwater are most likely to incur the highest costs. To estimate the potentially affected population, we used data from the 1980 *Census of Population and Housing* on drinking water sources for the 1,437 potentially contaminated counties (*74*). The census provides data on populations using water from private wells and from public systems.[12] In its statistics on public sup-

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[12] The term "public system," as used in this report, refers to both public and private water supply systems which serve six or more households.

Figure 8

Potential Groundwater Contamination from Nitrogen Fertilizers

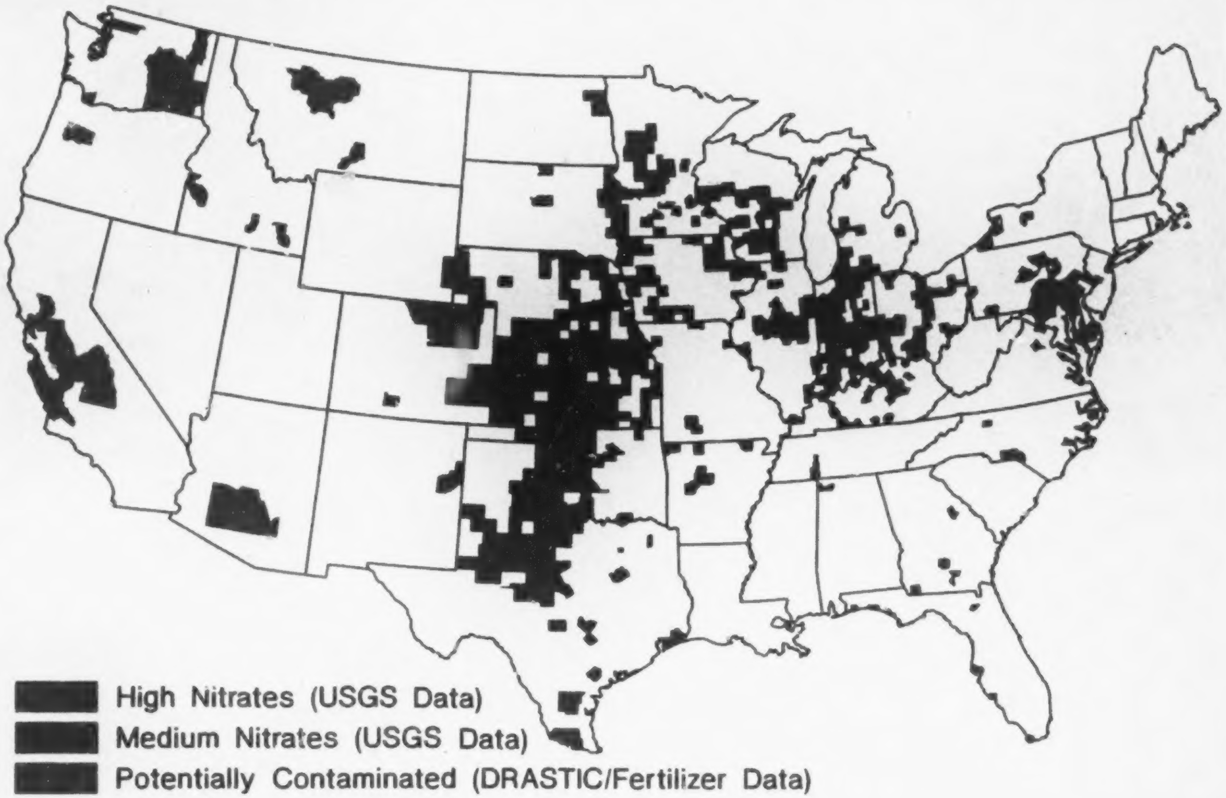
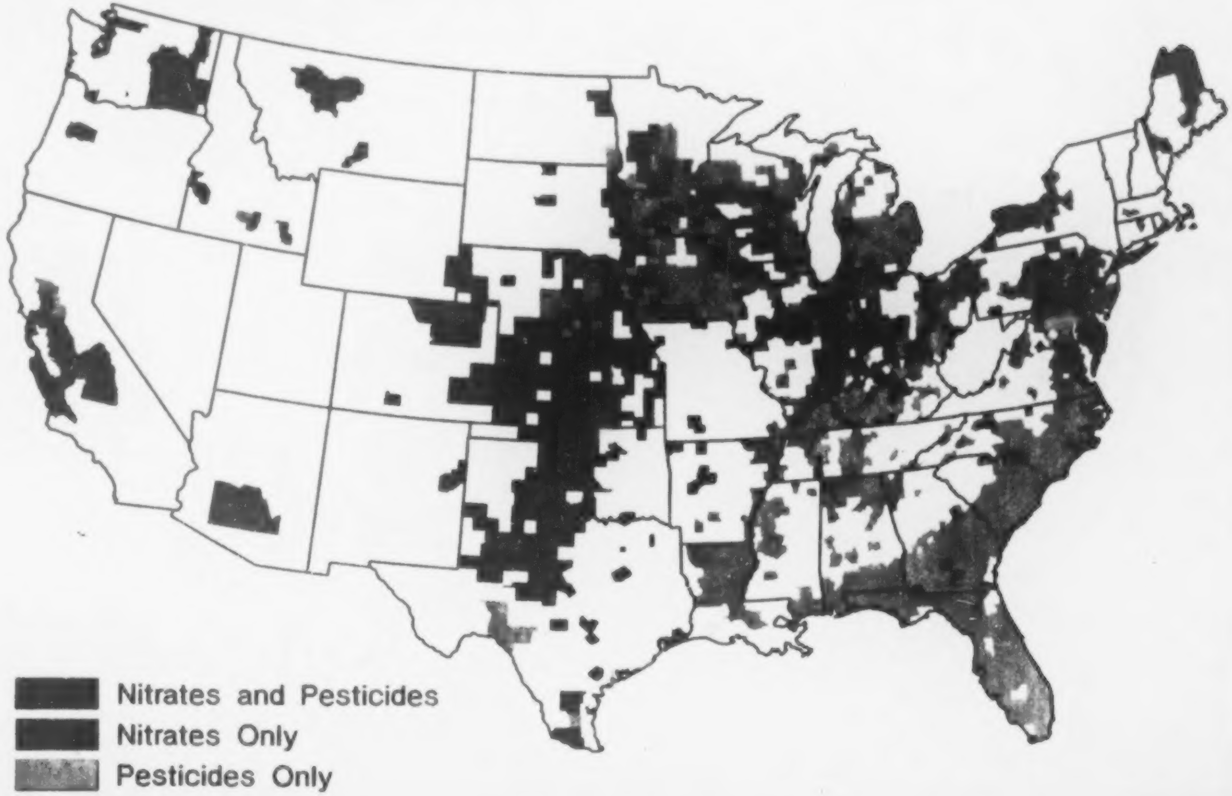

High Nitrates (USGS Data)
Medium Nitrates (USGS Data)
Potentially Contaminated (DRASTIC/Fertilizer Data)

Figure 9

Areas of Potential Groundwater Contamination from Agricultural Chemicals



Nitrates and Pesticides
Nitrates Only
Pesticides Only

plies, the census does not differentiate between surface water and groundwater sources.

Over 19 million people in these counties obtain their drinking water from private wells (table 2). Over 65 percent of these people (12.6 million) live in areas where only potential pesticide problems are predicted, while less than 10 percent (1.7 million) live in areas with only potential nitrate problems. The remainder (5.1 million) reside in areas with a potential for both pesticides and nitrates in groundwater.

Figure 10 depicts the geographic distribution of people relying on private wells. Counties with at least 40,000 people using private wells are found in parts of Florida and North Carolina; portions of the Northeast including areas in Delaware, New Jersey, northern Maine, Pennsylvania, and northwestern New York; parts of the northern Midwest (particularly Michigan and Wisconsin); and in several portions of central California. Areas with at least 10,000 but fewer than 40,000 people using private wells are usually found surrounding the counties having the highest populations using wells. Other counties in this range can be found in the Northwest, in Arizona, and in scattered parts of the Great Plains, Midwest, and Southeast. Areas consistently showing lower levels of population using private wells are predominantly in the Plains States, portions of the Midwest, and in western Kentucky.

In these 1,437 counties, 19 percent of the population relies on private wells for their drinking water. In contrast, in all other countries in the conterminous United States (that is, all unshaded counties in figure 10), only 12 percent of the population use private wells as their drinking water source. Overall, private wells are more vulnerable to contamination than deeper, regulated public wells. Thus, not only do people in the areas we identified appear to face a greater likelihood of groundwater contamination from agricultural chemicals but they may also face a greater probability of exposure, given contamination, because of their heavy reliance on private wells.

Since a consistent county-level data base on the population relying on public groundwater supplies for drinking water needs is unavailable, we developed estimates based on State-level figures.[13] We derived ratios of persons served by public groundwater supplies to persons served by all public supplies from USGS data (65). We then applied these ratios to the county-level data on populations served by public water supplies. This methodology implicitly assumes that little or no within-State variability exists with respect to public groundwater supplies. As a result, there may be discrepancies between actual and estimated populations relying on public groundwater supplies in some areas.

Table 2—Population obtaining drinking water from private wells in potentially contaminated areas

Contamination type	Persons
	Thousands
Nitrates only	1,674
Pesticides only	12,592
Nitrates and pesticides	5,075
Total	19,341

An estimated 34.5 million people living in areas of potential contamination are served by public groundwater systems. Table 3 shows State-level statistics, derived by summing the individual county estimates. Florida, Illinois, Indiana, Ohio, California, Iowa, Minnesota, Michigan, Wisconsin, New Jersey, New York, and Pennsylvania all have populations of at least 1 million estimated to depend on public drinking water supplies. Add to these the 19 million people who rely on drinking water from private wells, and there are a total of nearly 54 million people living in potentially contaminated counties who obtain their drinking water from underground sources, both public and private.

As with users of private wells, the majority of the 34.5 million people served by public groundwater systems (68 percent) reside in areas with only potential pesticide contamination. The rest are divided nearly equally into those living in areas of potential nitrate contamination only and those living in areas of both potential pesticide and nitrate contamination. Table 4 breaks down the estimated population using public groundwater supplies according to type of potential contamination.

Summary

The data presented in figures 4-10 have several implications for defining the magnitude of groundwater contamination from agricultural chemicals. First, they indicate that groundwater contamination from agricultural chemicals is not national in scope. Areas of potential contamination appear to be regional, often extending beyond local or State jurisdictions.

Second, they indicate that pesticides and nitrates in groundwater do not necessarily occur together. In fact, in three-fourths of the 1,437 potentially contaminated counties, pesticide and nitrate problems are not predicted simultaneously. The presence of nitrates may suggest pesticide problems and vice versa, but the association is weak. This finding suggests that strategies for controlling the entry of pesticides to groundwater may need to be different than those aimed at controlling groundwater contamination due to nitrates.

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[13] The EPA Federal Reporting Data System data base (FRDS), which is collected primarily for regulatory purposes, contains information on all public water supplies in the country. We explored the possibility of using this system to obtain county-level data but found that critical data items such as population served were inconsistently reported across States, making a broad geographical analysis impossible.

Figure 10

Distribution of Population Using Private Wells in Potentially Contaminated Areas

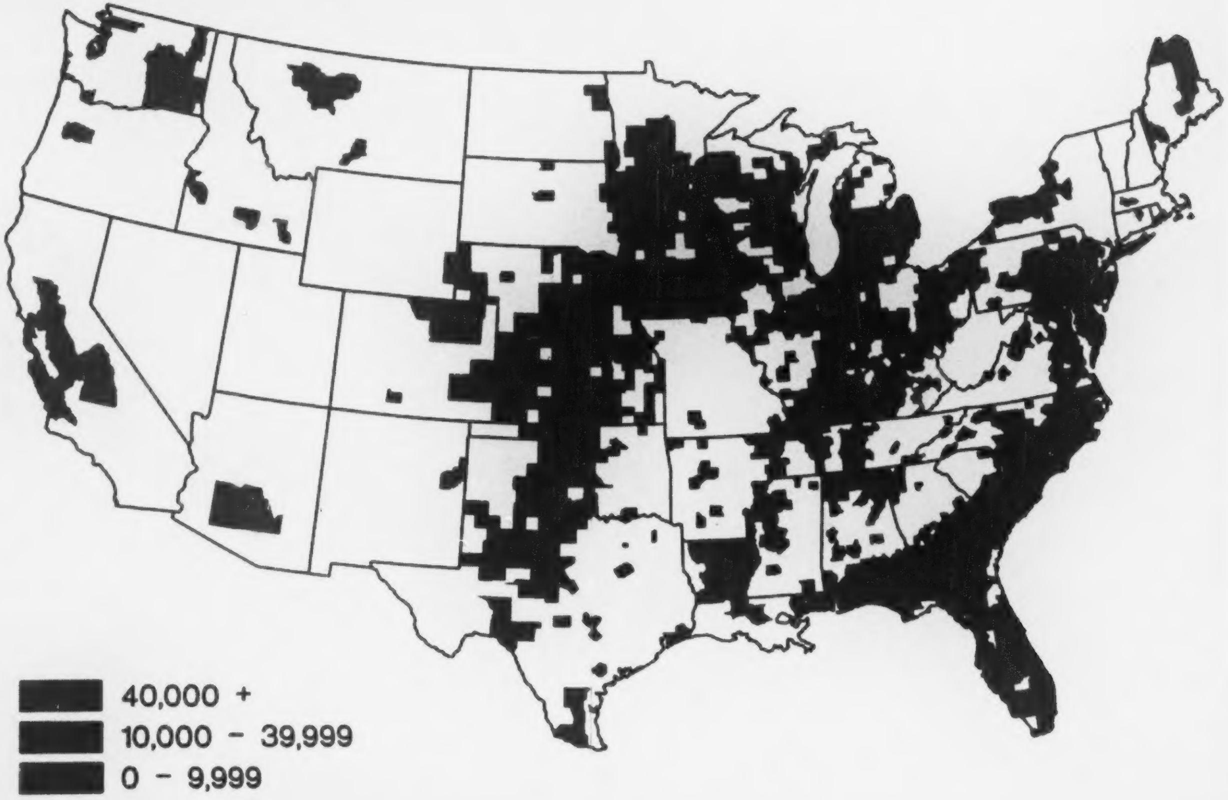
40,000 +
10,000 - 39,999
0 - 9,999

Table 3—Population served by all public water supplies in potentially contaminated areas, by State

State	Persons served by public supplies with a groundwater source[1]	Potentially contaminated counties		Persons served by public water supplies in potentially contaminated counties	
				Surface water and groundwater	Groundwater only (estimated)[2]
	Percent	*Number*	*Percent*[3]	*Thousands*	
Alabama	41	38	57	1,579	648
Alaska	60	NA	NA	NA	NA
Arizona	61	2	14	1,547	944
Arkansas	52	17	23	386	201
California	43	16	28	4,115	1,769
Colorado	13	14	23	842	110
Connecticut	21	1	13	44	9
Delaware	51	3	100	446	227
Florida	87	60	91	7,600	6,612
Georgia	32	93	59	1,587	507
Hawaii	95	NA	NA	NA	NA
Idaho	83	6	14	271	225
Illinois	38	58	57	7,364	2,798
Indiana	57	83	91	3,679	2,097
Iowa	75	93	94	2,151	1,613
Kansas	52	88	74	1,741	905
Kentucky	15	95	80	1,674	251
Louisiana	59	31	50	1,166	688
Maine	21	4	25	223	47
Maryland	12	21	91	2,557	307
Massachusetts	29	1	8	99	29
Michigan	20	51	61	6,382	1,276
Minnesota	65	62	71	2,145	1,395
Mississippi	91	24	29	653	595
Missouri	32	10	9	293	94
Montana	35	5	9	85	30
Nebraska	78	69	74	980	764
Nevada	46	0	-	-	-
New Hampshire	52	0	-	-	-
New Jersey	46	13	62	2,696	1,240
New Mexico	91	1	3	8	7
New York	22	21	37	5,593	1,230
North Carolina	15	66	66	2,006	300
North Dakota	51	3	6	82	42
Ohio	33	60	68	6,089	2,009
Oklahoma	28	33	43	501	140
Oregon	29	1	3	53	15
Pennsylvania	25	43	65	5,093	1,273
Rhode Island	16	1	20	63	10
South Carolina	23	30	65	1,353	311
South Dakota	71	10	16	156	111
Tennessee	39	32	34	1,839	717
Texas	44	67	26	1,986	874
Utah	51	0	-	-	-
Vermont	35	0	-	-	-

See notes at end of table.

Continued—

Table 3—Population served by all public water supplies in potentially contaminated areas, by State—Continued

State	Persons served by public supplies with a groundwater source[1]	Potentially contaminated counties		Persons served by public water supplies in potentially contaminated counties	
				Surface water and groundwater	Groundwater only (estimated)[2]
	Percent	*Number*	*Percent*[3]	*Thousands*	
Virginia	18	43	45	1,182	213
Washington	64	13	33	484	310
West Virginia	31	4	7	105	32
Wisconsin	53	50	69	2,718	1,441
Wyoming	38	1	4	7	3
Total[4]		1,437		81,850	34,492

- Indicates that, according to the analysis, there are no potentially contaminated counties in the State.

NA indicates States not included in the analysis.

[1] Calculated as the total State population served by public groundwater supplies divided by the total State population served by all public supplies.

[2] Estimated by multiplying the number of people served by public surface water and groundwater supplies by the percentage of people served by public supplies with a groundwater source.

[3] Calculated as the number of potentially contaminated counties divided by the total number of counties in the State.

[4] Totals may not add due to rounding.

Sources: (65, 74).

Table 4—Population using drinking water from public groundwater supplies in potentially contaminated areas[1]

Contamination type	Persons
	Thousands
Nitrates only	5,401
Pesticides only	23,450
Nitrates and pesticides	5,641
Total	34,492

[1] Numbers are estimates.

Finally, according to this assessment, chemical contamination of groundwater from agriculture primarily affects farming and rural areas, but has a potential effect on a significant part of the entire U.S. population, 53.8 million people. This large potential effect results from the density of population in the affected areas and a heavy reliance on groundwater.

Potential Effects and Costs of Agriculturally Contaminated Groundwater

The economic significance of the findings shown in figures 4-10 is reflected in the costs that society and individuals incur from agriculturally contaminated groundwater. Table 5 summarizes potential effects and documented incidents. As the table shows, the effects could be potentially very significant, particularly in terms of human health. However, available data on contamination occurrences and costs are very limited at the national or regional level, making direct assessment difficult. Some analysis has been undertaken to measure the environmental and social costs, although an examination of these estimates reveals problems inherent in developing national cost assessments from extrapolations of limited or local data (*51*).

Assessing and Regulating Human Health Risks

The primary potential effects of agricultural chemicals in groundwater are human health risks. Evidence on human health risks associated with nitrates and pesticides in groundwater, however, is spotty and often contradictory for several major reasons.

First, while acute toxicities can be evaluated from laboratory research and accident case studies, risks from low-dose exposures over a long period of time are much more difficult to evaluate. If there is an effect, it may take years or decades to develop so that "cause and effect" is difficult to establish. Scientists, therefore, must often make inferences from high-dose responses to low-dose responses, or from animals to humans.

Second, synergistic effects, or reactions from chemicals in combination, are extremely difficult to analyze. A factor that further compounds risk assessment problems is the difficulty of detecting some water pollutants at very low concentrations.

Finally, people can be exposed to pesticides and nitrates in a variety of ways. Besides ingesting water, people may be exposed to pesticides and/or nitrates from the food they eat. Contaminated household water can also lead to exposure to some organic chemicals from inhalation or skin absorption during showering or bathing. Pesticide applicators are subject to potentially high exposure levels if they do not take adequate

? precautions. In theory, all routes of exposure should be accounted for in risk analysis. In practice, risk assessment researchers normally assume that 20 percent of a person's daily intake of a particular drinking water contaminant actually comes from drinking water (76).

EPA is responsible for developing primary regulations for pollutants that may adversely affect human health under the guidelines of the Safe Drinking Water Act. Under the act, Maximum Contaminant Level Goals (MCLG's) are set for certain drinking water contaminants, based on established "safe" levels. The MCLG is a nonenforceable health goal for chronic exposure to those contaminants and it is set to zero for carcinogens. The Maximum Contaminant Level (MCL) is an enforceable standard that is set as close to the MCLG as possible, given available treatment technology. EPA also establishes Health Advisories (HA's) for some chemicals, which are nonenforceable standards for short-term exposures.

EPA regulations apply to the 58,000 "community" water supplies in the United States that serve 25 or more people or have at least 15 service connections. "Noncommunity" systems, which serve transient populations (for instance, restaurants and campgrounds) must comply only with those regulations for pollutants thought to have potentially acute health risks (76). Monitoring requirements are stricter for systems drawing from surface water sources (such as reservoirs) than for groundwater systems. Residential water supplies, on the other hand, are unregulated by EPA.

Health Risks of Nitrates and Pesticides

Few documented human health risks have been attributed to direct exposure to nitrates. More health problems have been traced to nitrites. Once nitrates enter the body, some proportion is converted to nitrites. Bacteria in the mouth and, to a lesser extent in other parts of the digestive system, convert nitrate to nitrite. The percentage of nitrate converted to nitrite in the body apparently varies among individuals and no human conversion factor is now known. However, the major way the body forms nitrites is thought to be by bacterial reduction of nitrate in saliva (47).

Table 5—Potential effects of groundwater contaminated by agricultural chemicals

Effects	Documented incidents	Costs incurred
Agricultural:		
Livestock poisoning and health problems	Nitrate/nitrite poisoning of livestock.	Unknown
Crop quality or quantity decreases	Salts leached from fertilizers can be concentrated through irrigation. Total contribution to salinity thought to be minor.	Unknown
Health risks:		
Methemoglobinemia from nitrites	Infant deaths and illness. Infant death in South Dakota, June 1986 tentatively linked with nitrogen fertilizer applications (*18*).	Unknown
Cancer	Herbicide use in Kansas linked with non-Hodgkin's lymphomas (*33*). Relationship between herbicides, groundwater contamination, and cancer unknown.	Unknown
Miscellaneous health problems from pesticides and nitrates	No conclusive documentation.	Unknown
Environmental:		
Damage to vegetation, waterfowl, and aquatic life in recharge areas and in surface water contaminated by agricultural chemicals in the groundwater	No conclusive documentation.	Unknown

The best documented human health risk from nitrites is infant methemoglobinemia. Nitrates are reduced to nitrites in an infant's digestive tract, apparently because a newborn lacks acidity in the stomach and upper part of its intestinal tract. Infants absorb nitrites into their bloodstream where the nitrites interact with hemoglobin to produce methemoglobin. Because that substance does not carry oxygen to body cells, the body's oxygen supply is reduced. Very high concentrations of nitrates in drinking water can be fatal to infants, particularly within the first 3 months of life. Reported instances of deaths from infant methemoglobinemia in the United States are rare. However, the true incidence is unknown because cases are not required to be reported. Several other categories of individuals are susceptible to methemoglobinemia, including pregnant women. Bottled water is now recommended in the United States where nitrate levels in the water exceed the Interim MCL of 10 mg/L. The MCL for nitrates applies to both community and noncommunity systems (*76*).

Though carcinogenic effects of nitrites have been investigated, a more direct cancer link has been traced to nitrosamines than to nitrites. Nitrosamines can be formed when nitrites combine with other substances such as amines. Most researchers agree that it is beyond question that nitrosamines are potent carcinogens for a wide range of target organs in many animal species (*48*).

However, because studies on humans are limited and in some cases produce contradictory results, it is difficult to prove conclusively that nitrites or nitrosamines are true risk factors in the development of forms of human cancer. The weight of animal evidence and results of limited human studies suggest that an association between nitrate consumption and its reduced forms of nitrites/nitrosamines and human cancer is plausible. Until further studies are conducted, no definitive conclusions can be reached.

The degree of risk associated with using and ingesting water containing pesticide residues is also much-studied but poorly understood. Since all pesticides are designed to be toxic to certain forms of life and because few are completely selective in their actions, most could adversely affect human health, depending on their concentrations. The degree of toxicity and the nature of the effects vary widely with the pesticide, as does the degree of knowledge about the mechanisms and effects of pesticide action (*45*).

Based on risk assessments, EPA canceled the uses of two nematicides, EDB and DBCP, due to evidence that they cause genetic mutations, reproductive disorders, and cancer (*76*). Both chemicals have been found in groundwater. Other chemicals are currently being studied by EPA. For example, alachlor, an acetanilide herbicide widely used on corn and soybeans and found in groundwater in four States, has also shown strong evidence of being a carcinogen (*76*). Triazine herbicides (for example, atrazine, cyanazine, and simazine) are groundwater contaminants and, though not known to be carcinogens, are suspected of causing long-term effects including central nervous system (CNS) disorders (*22*). Widely used phenoxy acid herbicides which are potential leachers, such as 2,4-D, 2,4,5-T, and 2,4,5-TP (Silvex), are also suspected of causing CNS disorders and a variety of other chronic effects (*22, 43*). A recent study has linked the application of 2,4-D with certain forms of cancer in farmers (*33*). MCLG's have been established for six pesticides: endrin, lindane, methoxychlor, toxaphene, 2,4-D, and 2,4,5-TP. EPA is currently developing MCLG's and MCL's for additional pesticides and other organic chemicals (*66*).

While the actual risks from low-level exposure to agricultural pollutants are uncertain, the public perception appears to be that they are significant. A recent national public opinion survey of randomly selected people found that only one person in five believes that drinking water which has small amounts of chemicals but which satisfies Government regulations is safe to drink. Moreover, one-third of the respondents said either that they thought their home drinking water was unclean or that they were not sure about its safety. One-fourth either drank bottled water or used a filtering system for their household water (*7*). Readers of *National Wildlife* magazine, presumably a group with a higher than average awareness of environmental issues, rank drinking water contamination as the number one environmental threat, according to a 1986 survey (*49*). Avoiding drinking water contaminated by agricultural and other chemicals is a clear priority of many, despite the lack of definitive answers about health risks.

Measuring Social Costs

Because it is difficult to directly address the costs to society from chemicals in groundwater by means of a risk assessment process, researchers have estimated the social costs of preventing or avoiding groundwater contamination. Estimations can be based on expenditures associated with groundwater protection procedures. Raucher, for example, has examined the benefits and costs of groundwater contamination policies using a "damages avoided" framework on a site-by-site basis (*55, 56*). Such an approach has several limitations, however, as Raucher notes. It ignores values that society may place on uncontaminated aquifers independent of current or anticipated use. Option values, existence values, or bequest values have been extensively discussed in the resource economics literature and some limited evidence suggests that the size of these benefits may be significant. Raucher also notes that the framework he proposes is useful for a case study analysis but may not be equally applicable to a more comprehensive analysis. The magnitude of benefits from protecting any one aquifer may be small in isolation, but the contamination of many aquifers could be extremely costly to society.

Recognizing the limitations, this report uses a "damages avoided" approach to evaluate macro-level costs of agriculturally induced groundwater contamination. One way to estimate what society must pay to reduce an unspecified contamination risk is to appraise avoidance costs. To do this, we analyzed avoidance costs for households using private wells and public systems. We studied the household sector because private wells are a significant water source in potentially contaminated areas, and the health risks faced by households are the most widely cited effect of groundwater contamination.

Figure 11 presents a framework for household decisionmaking in areas facing groundwater contamination. The first step in any decisionmaking process is to obtain information about potential risks. In the case of groundwater, this information gathering is normally done by sampling well water and conducting laboratory tests. If positive test results are obtained and verified, households can assess the information based on their own risk preferences.

If the monitoring information indicates that groundwater contamination is a problem, or if a household decides that it faces significant risks, remedial action can then be taken. Bottled water, filters, or new wells are the most likely alternatives for rural households. Hooking up to deeper, public system wells may be an alternative for some households.

For a household situated in a potentially contaminated area where no immediate remedial action is needed, resampling for contaminants at periodic intervals is probably desirable. Remedial action may be necessary later.

A framework of this kind suggests that estimating what household monitoring costs will be is the first step in appraising groundwater contamination avoidance costs. Because appropriate remedial responses can only be determined on a site-specific basis, estimating remedial response costs for potentially contaminated counties is infeasible. Instead, we discuss a range of remedial options for households and public systems.

Monitoring Costs

Using the framework shown in figure 11, the first step in estimating avoidance costs is to determine monitoring costs. We estimated monitoring costs for households in potentially contaminated areas as well as those of public systems for comparative purposes.

Households. Not every household in a potentially contaminated area would choose to undergo monitoring. Some would decide that any potential risk warrants remedial action, bypassing monitoring altogether. Others may decide that no matter what the monitoring results indicate, no action is necessary. Our current data base does not allow us to determine individual risk preferences. Consequently, the household monitoring costs we provide are estimates of initial monitoring costs of all households served by private wells in areas of potential groundwater contamination, given the assumptions made in the analysis. These estimates can be used, however, to make comparisons between monitoring costs for pesticides and nitrates and between monitoring costs for private wells and public systems. The comparisons have useful implications for public policies.

To estimate household monitoring costs, we obtained a list of laboratories from EPA which are capable of testing water for pesticides and nitrates.[14] We selected a sample of those laboratories located in the 1,437 potentially contaminated counties and obtained price information on nitrate and pesticide testing. Since prices of public laboratories may not reflect market prices, only estimates from private laboratories were used in the analysis.

The laboratories provided cost analysis information on nitrates and pesticides that can be analyzed by four EPA-approved analytical methods. The pesticides were alachlor, metribuzen, bromacil, atrazine, aldicarb, carbofuran, methomyl, dinoseb, and 2,4-D. These pesticides were selected from the 38 used in our analysis of potentially contaminated areas.

Based on discussions with the University Hygienic Laboratory of the University of Iowa and with private laboratories, we developed several criteria for determining monitoring costs. These criteria and the assumptions we used are:

1. The number of chemical tests performed is a major determinant of monitoring costs. Although groups of pesticides can be analyzed with one laboratory method, each chemical requiring a separate procedure is priced individually. Thus, the number of tests performed rather than the number of chemicals analyzed determines the cost. We assumed that two chemical tests for pesticides were conducted.
2. The resampling required to assure quality control varies widely from laboratory to laboratory depending on the reliability of the analytic procedure used. A 33-percent resampling rate for nitrates and pesticides was used in our analysis to allow for quality control analysis of positive results.
3. Pesticide testing costs vary widely across laboratories. No discernible regional patterns were

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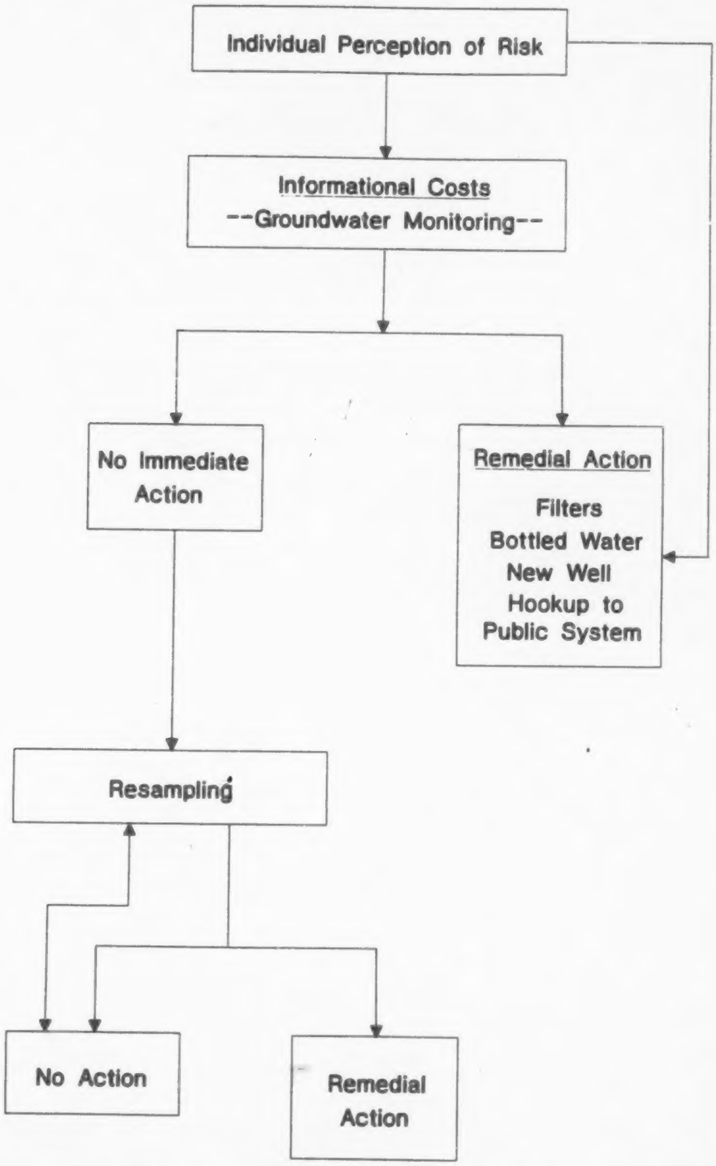
[14] This list was provided by Maria Gomez-Taylor, Office of Drinking Water, EPA.

Figure 11

Household Decisionmaking in Areas with Potential Groundwater Contamination


Individual Perception of Risk
Informational Costs
--Groundwater Monitoring--
No Immediate Action
Remedial Action
Filters
Bottled Water
New Well
Hookup to Public System
Resampling
No Action
Remedial Action

detected. Water sample bottles were sometimes included in the laboratory prices. The type of test performed was a major determinant of cost, but laboratories did not uniformly charge more for a particular test. Pesticide laboratory costs, including bottles, were estimated to average from $53 to $139 per test, with $84 a midpoint.

4. Testing for nitrates is a much simpler procedure than testing for pesticides. Our estimates on nitrate costs, including bottles, range from $10 to $25, averaging $16.

5. Shipping and labor costs add to monitoring costs because households must collect samples and mail them to laboratories. One-half hour of labor to collect samples was estimated at an hourly wage rate of $3.35, or $1.68. Shipping costs were estimated to be $1.30 for a 4-ounce nitrate sample, and $3.50 for an 8-pound pesticide sample for two tests. Pesticide tests require larger water samples than do nitrate tests. A 100-mile distance was used to estimate shipping costs with both the United Parcel Service and the U.S. Postal Service. An average of the costs of the two shippers was developed. Estimated shipping and labor costs were $3.00 per well for nitrates and $5.18 per well for pesticides, with and without additional tests for nitrates.

Table 6 shows cost estimates for monitoring various agricultural contaminants per private well. The wide-ranging costs for detecting pesticides reflect laboratory costs which were estimated by averaging data on four pesticides: alachlor, atrazine, aldicarb, and 2,4-D. Variations in nitrate costs also reflect laboratory cost differences.

We multiplied the estimates of monitoring costs by private well in table 6 by estimates of the numbers of private wells in potentially contaminated areas derived from census data on nonpublic well systems (table 7). Approximately 10.9 million private well systems are in use in the 1,437 potentially contaminated counties. The calculations include a 33-percent resampling rate.

Data in table 7 reflect a range of initial monitoring costs for these private wells. The estimates range from a high of $2.2 billion to $0.9 billion, depending on the laboratory cost estimate used. The average or "best" estimate is $1.36 billion. Although these estimates reflect the upper limits on the number of wells monitored, other assumptions in the analysis, such as the resampling rate and number of tests performed, may yield more conservative estimates. A study conducted by the Iowa Department of Water, Air, and Waste Management supported that view. The study reported that shallow wells serving six city water supplies in northwestern Iowa contain pesticides and other synthetic organic chemicals (*38*). Seven wells serving five communities contained measurable amounts of pesticides, although the levels did not violate any MCL standards. Furthermore, the contamination often involved more than one chemical. In one case, a well contained six pesticides. The Iowa study suggests that many wells in potentially contaminated areas may have low concentrations of pesticides, possibly indicating a need for a higher resampling rate (greater than 33 percent) and more than two laboratory tests.

In addition, in cases where low concentrations of pesticides are detected, it is likely that monitoring will be an ongoing process rather than a one-time cost. Consequently, some portion of the initial estimate of $1.36 billion for monitoring costs could be spent annually.

Table 8 presents monitoring costs by contaminant. Only $14 million of the $1.36 billion in monitoring costs are attributable to nitrates alone. Pesticides, alone or in combination with nitrates, represent the majority of monitoring costs because they affect a larger geographical area and incur higher laboratory costs.

Figure 12 shows how monitoring costs are distributed regionally. High-cost counties (those with $1 million or more in monitoring costs) account for nearly 74 percent of total monitoring costs nationwide and are con-

Table 6—Monitoring cost estimates per private well by contaminant

Contaminant	Low	Average	High
		Dollars	
Pesticides and nitrates	123	189	308
Pesticides	113	173	283
Nitrates	13	19	28

Table 7—Range of initial monitoring costs for private wells in areas of potential groundwater contamination

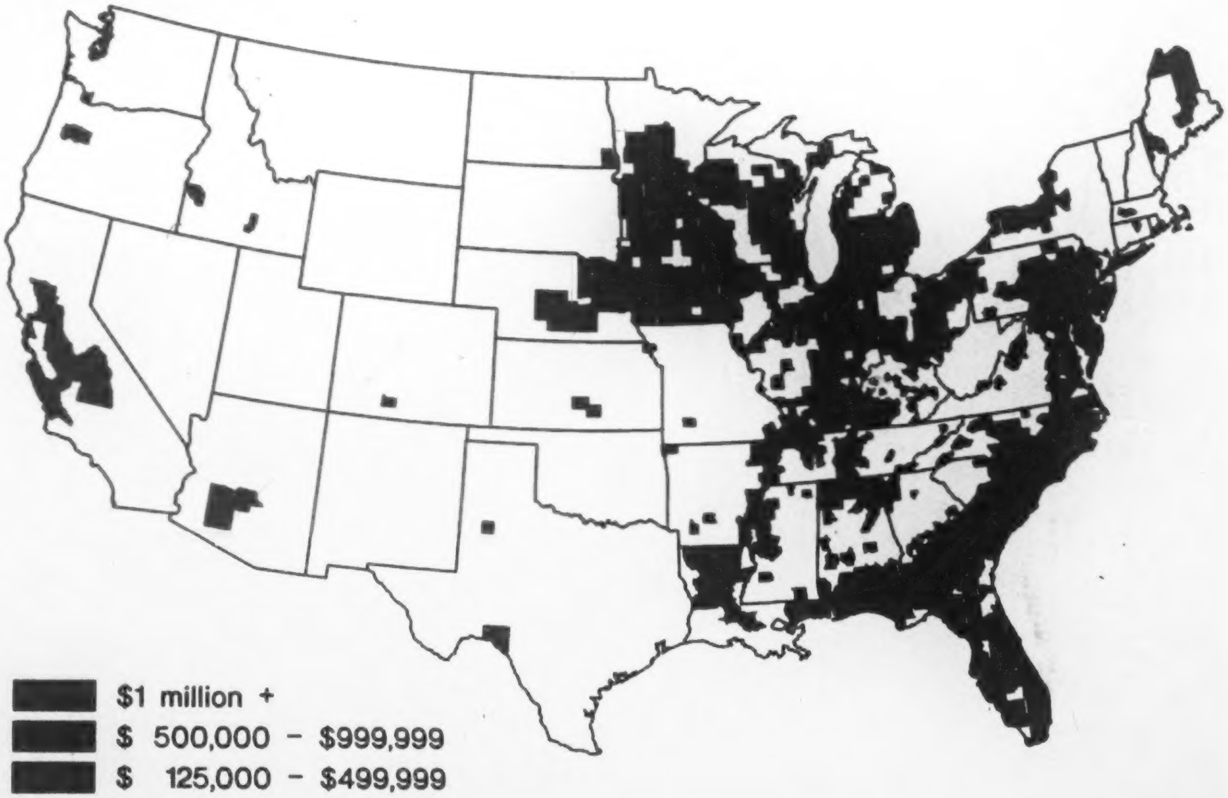
Monitoring cost assumptions	Cost
	Billion dollars
High	2.21
Average or "best"	1.36
Low	.89

Table 8—Initial monitoring costs, by contaminant, for private wells in areas of potential groundwater contamination

Contamination type	Total cost	Counties
	Million dollars	*Number*
Pesticides and nitrates	414	314
Pesticides	929	814
Nitrates	14	309
Total	1,357	1,437

Figure 12

Groundwater Monitoring Costs in Potentially Contaminated Areas


$1 million +
$ 500,000 - $999,999
$ 125,000 - $499,999

centrated in Wisconsin, Michigan, Ohio, Pennsylvania, New York, Maine, parts of the southeastern Coastal Plain, Florida, and California. These areas are more densely populated than other potentially contaminated locales. They average 230 persons per square mile compared with 102 persons per square mile in all areas with potential groundwater contamination. These areas also have a slightly higher percentage of population using private wells: about 21 percent compared with 19 percent in potentially contaminated areas nationwide. Finally, the areas with high monitoring costs are those which have high predicted potential pesticide contamination, or where pesticides and nitrates are potentially found together.

Public Systems. Approximately 34 million people living in the areas with potential contamination obtain their water from public systems drawing on groundwater. Public wells are also subject to groundwater contamination from agricultural chemicals, although they are likely to intercept deeper aquifers and draw from much larger areas than a typical private well. Public systems are usually more highly regulated than private wells, which are subject to no Federal regulatory standards. Nitrates, however, are the only agricultural chemical that community groundwater systems periodically analyze on a nationwide basis.

To compare contamination avoidance costs between private wells and public systems, we developed monitoring cost data for public systems in potentially contaminated areas. Because nitrates are monitored under an ongoing program, we analyzed only costs associated with pesticide monitoring. Our starting points were the county-level estimates of populations using public groundwater supplies, derived earlier in our analysis.

Because data were not available on the size distribution of public groundwater systems, we assumed that the average public system in the study counties serves 3,300–10,000 people. Then we applied EPA assumptions about a public system of this size.[15] For an analysis of the costs associated with implementing standards for volatile organic chemicals (VOC's), EPA assumed that a system of this size would be served by eight wells with four entry points. Further, samples are taken at each entry point, so that an average of four samples per year is taken for each chemical. EPA assumed a 30-percent resampling rate to screen for VOC's in systems serving more than 3,300 people.

We added to the EPA assumptions one more assumption made in the analysis of private wells; namely, that two chemical tests would be performed. We presumed a 5-percent quantity discount on laboratory costs for a system of this size. Monitoring costs for a typical system then became the product of:

$160 (the average cost of two chemical tests at $84 per test with a 5-percent quantity discount) and

4 (the number of entry points) and

4 (the number of samples per year),

or $2,560.

We do not know the number of public groundwater systems in the 1,437 potentially contaminated counties. There are, however, approximately 29 million people served by public groundwater systems in counties with pesticide contamination potential. Dividing $2,560 by the midpoint of the population served by a typical system (6,650) yields a monitoring cost estimate of $0.38 per person. Multiplying the per-person cost of $0.38 by 29 million people would result in a total of nearly $11 million in initial monitoring costs for a 1-year period. Assuming a 30-percent resampling rate to confirm positive samples, initial monitoring costs for public systems in potentially contaminated areas would be $14 million.

As with household monitoring costs, the choice of assumptions can determine cost estimates. If the average public system serves fewer than 3,300 people and/or if more than two chemical tests are performed, the estimate would increase. On the other hand, if the average system serves more than 10,000 people, the estimate would decrease. Limited data on public groundwater systems prevents developing more precise estimates. However, even if we allow for a confidence interval of ±100 percent for public system monitoring costs, those costs are significantly less than the $1.4-billion estimate developed for private wells in the same areas. The major reason for large differences in monitoring costs between private and public systems is that public groundwater systems afford economies of size.

Summary. The monitoring cost approach does not directly address the costs of damages society incurs from groundwater contamination caused by agricultural chemicals. Lack of documentation about health and other risks makes such an aggregate damage assessment difficult. The monitoring cost approach also ignores values society may place on uncontaminated groundwater for reasons independent of current or anticipated aquifer use.

We present the monitoring cost data to partially illustrate the costs households and communities incur in identifying risks. Monitoring is often the first, informational step in an avoidance strategy. While measuring monitoring costs does not directly ascertain risk preferences of people in affected areas, it does allow useful comparisons among groundwater users in potentially contaminated counties.

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[15] Unpublished data provided by Maria Gomez-Taylor, Office of Drinking Water, EPA.

The data suggest that the costs of avoiding risks imposed by groundwater contamination from agricultural chemicals are potentially significant. Initial monitoring costs for households would range between $0.9 and $2.2 billion, with $1.4 billion being a "best" estimate. Monitoring for pesticides constitutes the major expense.

The data also clearly indicate that, within the potentially contaminated areas, the consequences created by agricultural chemicals in groundwater will be borne by the rural sector. Because monitoring costs are the same regardless of well size, communities with more and larger volume w[illegible] can spread monitoring costs over a network of users. In addition, quantity discounts are likely available. Private well owners, on the other hand, must directly bear all costs, whether they are for monitoring or remedial action. Thus rural residents who rely on private wells, and farmers in particular, will incur a large portion of the expenses.

Remedial Responses

Communities and households have a number of options available to them in responding to known or suspected contamination (see fig. 10). Possible responses range from accepting perceived risks (continuing to drink the water) to avoiding risk (adopting a remedial strategy). We provide only a brief overview of these options, not a decisionmaking guide.[16] We make no attempt to relate remedial costs to the identified potentially contaminated counties because the choice of remedial options depends on the risk preferences of individual well owners and on local conditions.

Households. Households seeking to avoid potential risks from chemicals in their drinking water may choose either to remove the contaminant(s) from the water or to obtain alternative drinking water supplies. The alternative chosen will depend on the costs and effectiveness of the various options, and on household preferences. Table 9 summarizes the major options available and their estimated costs.

Installing home water treatment ("point-of-use") units can reduce contaminants in water that is publicly or privately supplied. The type of contaminant and the natural constituents in the water will determine which kind of device should be used. Pretreatment for natural substances such as iron might be necessary to ensure that treatment for pesticides or nitrates will be effective.

Cost ranges for treatment units shown in table 9 reflect in part the system's capacity and coverage (for example, single-tap or whole-house treatment). Costs also vary with the way that dealers market their products, and while they may vary with the quality of the product, they do not necessarily reflect the unit's effectiveness. These units are not regulated by the Federal Government, nor are they regulated by many State governments.

Most treatment processes have periodic maintenance costs in addition to the purchase price. For instance, maintenance costs for activated carbon units include periodic filter replacement, which could cost from $200 to $350 annually for a whole-house system. Annual costs of replacing membranes and filters in reverse osmosis units could cost $100 to $150. Ion exchange units also require periodic maintenance to assure continued reduction of nitrates.

Households can obtain new sources of water by purchasing bottled water for drinking and cooking needs, connecting to a public water supply, or drilling a new

Table 9—Household remedial options to reduce agricultural chemicals in drinking water

Option	Estimated costs	
Water treatment unit:[1]		
Activated carbon filtration (to reduce pesticides)	Faucet-mounted: Under-the-sink: Whole-house:	$25-$50 $50-$300 $500-$800
Distillation (to reduce pesticides and nitrates)	Countertop: Automatic:	$300-$350 $600-$800
Ion exchange (to reduce nitrates)	Whole house:	$500-$800
Reverse osmosis (to reduce pesticides and nitrates)	Single tap:	$400-$600
Bottled water	$7-$15 weekly for a family of four[2]	
New well	$3.50-$4.50 per inch diameter per foot of depth, plus casing and pump costs[3]	
Hookup to public system	$12,000+ per household depending on distance to water main, plus water payments[4]	

[1] Cost ranges were estimated based on conversations with suppliers and trade representatives and information in published literature. (See boxed item for definitions of the various processes.) Estimates do not include maintenance costs.

[2] Costs are based on use of 2 liters per person per day for drinking water only, with prices ranging from $0.13 to $0.26 per liter ($0.50 to $1.00 per gallon).

[3] Costs are for a well up to 8 inches in diameter and up to 300 feet in depth. They will be higher if the ranges are exceeded. Prices were updated to 1986 levels with the Consumer Price Index. Source: (*75*).

[4] Sources: (*15, 34*).

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[16] The descriptions and costs presented are based on information in published sources and from discussions with treatment unit manufacturers and suppliers, water quality association representatives, and local public officials.

Water Treatment Terms

Activated carbon filtering—A process that relies on adsorption to remove gases, liquids, and/or suspended matter from water. The water is filtered through carbon, usually in the form of granular activated carbon (GAC). Faucet-mounted and under-the-sink units connect to a single tap, while whole-house units connect to the main water line.

Distillation—A process in which water is converted to its vapor state by heating, after which the vapor is cooled and condensed to the liquid state and collected. It is used to remove solids and other impurities from water. Water is poured by hand through countertop distillation units. Automatic units are connected directly to a water tap.

Ion exchange—A process that uses resins having an affinity for certain ions to draw particular substances from water. Anion exchange is the appropriate ion exchange process for reducing nitrates. Units are usually sold as whole-house models.

Reverse osmosis—A process in which pressure is used to force water through a semipermeable membrane which transmits water but rejects most other dissolved ions. Most household models have GAC filters attached, and connect to a single tap.

and deeper well. In some cases, bottled water is used as a short-term water source until a new permanent supply is secured.

Drilling a new well may be a feasible household response to contamination if an acceptable deeper water source is available. To jusify the expense, however, the probability of eventual contamination of the deeper source must be low. The costs of installing a new well can be quite high, as table 9 indicates, and can vary depending on the season and the availability of local drillers (*75*). In the Big Spring area of northeast Iowa, where wells must be drilled 450 to 500 feet deep to reach uncontaminated groundwater, a new well could cost, conservatively, $6,750 (*40*).

Connecting to a public water system is often the safest alternative for owners of contaminated wells, although the expense may be prohibitive if water mains are not reasonably close. In Connecticut, the cost to extend water lines to houses with contaminated wells was found to range from $12,000 to $20,000 (*34*). In areas where housing density is lower and/or distances to water mains are greater, the costs could be substantially higher. Moreover, households connected to public systems usually must pay for their water, unlike those with private wells.

Even if distance to water lines and cost are not prohibitive, there may be other barriers or drawbacks. For example, some water districts do not have enough extra capacity to service new demand. Also, public water supplies are not necessarily free of all agricultural chemicals.

Public Systems. Communities, like households that find their water supply wells to be contaminated, have a number of potential remedial choices open to them. Some options to control point sources of contamination from hazardous waste sites, such as plume containment or control strategies, would likely be technically infeasible or unaffordable if used on agricultural nonpoint-source contamination.

Options which are sometimes workable include closing contaminated wells while maintaining water supply from purer wells, drilling new wells, purchasing water from nearby suppliers, or tapping surface water sources. In some cases, water from contaminated wells is blended with purer water to reduce the concentration of the contaminants by dilution. Conserving water also can help stretch existing supplies.

The technical and economic feasibility of the various options varies widely from one place to another. Some options are very expensive. For instance, drilling a new large-capacity well can run into the tens of millions of dollars.[17]

Like households, communities can reduce pesticide levels in their water with GAC filters. However, the process is not widely used at the community level; in 1984, the number of public water treatment plants using GAC adsorption for all purposes, including taste and odor control, was estimated to be between 50 and 60. (*68*). Table 10 presents estimated capital equipment costs and annualized per-unit GAC treatment costs for two system sizes. The operating expenses include periodic carbon regeneration. GAC filtering systems, as the table indicates, afford significant economies of size.

Treating community well water to reduce nitrates is uncommon. Because of high treatment costs, wells with high nitrate levels usually have been closed or their water has been mixed with water from other wells to bring nitrate levels to acceptable standards.

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[17] See, for example (*55*) and (*63*).

Table 10—Public groundwater supply treatment technologies and their costs

Treatment technology	Agricultural contaminant controlled	System size[1]	Capital equipment costs	Annualized costs per 1,000 gallons[2]
		Million gal/day	——— *Dollars* ———	
Granular activated carbon (GAC)[3]	pesticides	1	1,000,000	1.14
		100	25,000,000	.23
Reverse osmosis[4]	nitrates	1	800,000	.99
Ion exchange[4]	nitrates	.5	<100,000	.17
		1	<160,000	NA

NA indicates that data are unavailable.

[1] A 1-million-gallon-per-day (mgd) system serves approximately 5,000 people, while a 1,000-mgd system serves approximately 500,000 people.

[2] Includes annual operating expenses plus amortized capital costs.

[3] Costs are expressed in March 1980 dollars.

[4] Costs are expressed in 1981 dollars, and annualized costs do not include waste disposal expenses.

Sources: (17, 26).

The EPA Municipal Environmental Research Laboratory evaluated experimental reverse osmosis and ion exchange units for single contaminated wells in small community systems to bring nitrate levels in the final water supply (treated water mixed with raw water) to drinking water standards (26). Table 10 shows the cost involved.

The study indicated that the ion exchange process is preferable to reverse osmosis for small systems because it has lower capital equipment costs and fewer mechanical problems. Both systems generate wastes that require disposal, increasing potential unit costs by as much as 50 percent. Neither process for reducing nitrate levels was evaluated for larger systems, although the authors argued that economies of scale would make the processes more cost-effective for larger system sizes (26).

While these costs are only examples and can vary widely depending on location, they do show that treatment costs are potentially high. Costs vary and will be at the high end of the scale if supply systems are small and if the water contains both pesticides and nitrates. Because treatment costs for public water supplies can be high and because treatment is sometimes the only feasible alternative, programs that take a collective approach to providing point-of-use treatment of public water supplies are being studied and initiated in several small communities with polluted groundwater sources (6). Under these circumstances, communities set up legal entities that assume responsibility for purchasing and installing all point-of-use units, overseeing monitoring activities, and supervising maintenance. Providing individual treatment units to all affected households can result in lower capital outlays than those for central treatment, but an ongoing maintenance program is essential if all sites are to receive the desired quality of water (6).

Summary. The overview of remedial actions and their costs for households and public systems shows the range of options for treating contaminated groundwater or developing alternative drinking water sources. They vary widely in cost and effectiveness. Without precise knowledge of local conditions, it is impossible to predict how many households or communities would require remedial action or what type of action would be appropriate. Consequently, no national estimate of remedial costs in potentially contaminated areas is possible. The data presented in tables 9 and 10 do suggest, however, that some of the remedial actions could result in substantial costs to households with private wells and to small communities that rely on groundwater. Further, remedial actions that reduce both pesticides and nitrates in drinking water appear to be more costly than reducing only one contaminant. Areas with private wells and a simultaneous threat of pesticides and nitrates in their water thus could also face high monitoring and remedial costs.

Implications for Groundwater Protection Strategies

Despite limitations of the current data, the statistics presented in this report do serve as indicators of broad regional and national trends. These data have implications for groundwater contamination protection strategies nationwide.

The information suggests that farmer education programs can play a major role in preventing or minimizing groundwater contamination. If incentives for farmers to take voluntary action are ever going to be effective, it is likely to be in the groundwater contamination area. Farmers are much more directly affected by agricultural pollution of groundwater than of surface water because their wells are likely to be close to the sources of contamination. Currently there is little advice to give to farmers about how agricultural practices such as conservation tillage affect groundwater quality. The success of farmer education programs depends, in part, on well-documented research programs, many of which are just getting started.

The statistics also suggest that different strategies may be appropriate for dealing with nitrates than with pesticides. In areas of nitrate contamination, taxing fertilizers may be sufficient to offset well monitoring costs or to provide alternative water sources for those affected. It is noteworthy that about 556,000 private wells are located in areas potentially affected only by nitrate contamination compared with 5.6 million private wells in areas with a high potential pesticide contamination or combined pesticide and nitrate contamination potential. Moreover, monitoring costs for nitrates are relatively inexpensive, and the small number of private wells potentially affected may make a remedial program feasible.

In contrast, costs of monitoring for pesticides, whether alone or in combination with nitrates, are so high that a household monitoring program for 5.6 million wells, coupled with remedial actions, would be very costly. Prevention, rather than detection and remedial action, is a more probable strategy, particularly where pesticide contamination is to be avoided. Effective and economical onfarm prevention measures need to be developed.

The data clearly indicate that targeting is needed for any protection strategy. Not all regions are vulnerable. In those regions where agricultural chemicals are being used, not all are equally dependent on groundwater or are densely populated. The monitoring cost approach laid out in this report combines physical vulnerability characteristics, chemical use data, number of wells, and population data. Monitoring cost data shown in figure 12 suggest which regions should be given priority in targeting groundwater protection strategies.

Conclusions

The objective of this report was to define the physical and economic dimensions of the potential for groundwater contamination from agricultural chemicals in the United States. Major uncertainties remain concerning the human health risks and costs associated with contamination. Despite limitations of the data and analysis presented, the report sets the stage for further, more detailed analyses of the economic issues associated with agriculture and groundwater contamination. The development of economic analysis would depend on the simultaneous development of improved data on the physical processes of groundwater contamination.

A major research issue that will have to be addressed is the relationship between the social benefits and social costs of groundwater protection programs and policies. In the absence of any broad-based research results, policymakers are beginning to propose and enact legislation designed to safeguard groundwater from agricultural chemicals and other contaminants. Arizona, Wisconsin, and other States have already enacted groundwater protection legislation, and EPA is now formulating a strategy aimed at protecting groundwater from agricultural chemicals. Other legislative and regulatory measures are sure to be forthcoming, some of which may impose restrictions on the agricultural sector.

The costs of these regulatory measures on the agricultural sector are not yet well understood. The relationships among agricultural practices, farm income, and changes in groundwater contaminant levels remain to be defined and the economic damages to human health and property need to be directly addressed. All of this information is needed to compare the benefits of controlling societal damages from agriculturally induced groundwater contamination with the social costs of groundwater protection programs and policies. Such an analysis could lead to more efficient and effective strategies for controlling groundwater pollution from pesticides and fertilizers.

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Appendix—Data Sources for the Pesticides Assessment

We used two major data sources, the DRASTIC index and the pesticide usage data base developed by Resources for the Future, for the analysis of potential contamination from pesticides.

The DRASTIC Index: County-Level Assessments

The DRASTIC index is a system for evaluating an area's relative vulnerability to groundwater contamination from various sources of pollution (*4*). The hydrogeologic factors which determine the DRASTIC score and which are the basis for the acronym "DRASTIC" are: Depth to water, Recharge (net), Aquifer media, Soil media, Topography (slope), Impact of the vadose zone, and Conductivity (hydraulic) of the aquifer.

Each DRASTIC factor receives a rating for the geographic area under consideration. The rating is, in turn, multiplied by a weight which reflects the factor's relative importance to contamination potential. The weighted ratings are totaled, yielding the DRASTIC score. A higher score implies a higher degree of vulnerability.

Two sets of weights form the basis for two distinct DRASTIC indexes: the DRASTIC index for agricultural pesticides and the regular (generic) DRASTIC index for all other contaminants. Appendix table 1 shows the assigned weights for both the regular and pesticide DRASTIC indexes. The weights were derived by a committee that used a Delphi or consensus approach. In the case of the agricultural pesticide index, the committee arrived at the weights by considering characteristics of a "generic" pesticide (*3*).

Each DRASTIC factor is divided into either ranges or significant media types which have an impact on pollution potential, and each range has a corresponding rating (app. table 2). The DRASTIC score (or pollution potential) for the area is determined by the following formula:

$$\text{DRASTIC SCORE} = D_rD_w + R_rR_w + A_rA_w + S_rS_w + T_rT_w + I_rI_w + C_rC_w$$

where: r = rating
w = weight.

County-level DRASTIC assessments were carried out in 1985 under an EPA-sponsored project. The county-level ratings were used to aid in sample stratification for EPA's national survey of pesticides in well water (*2*). To derive the DRASTIC scores which we subsequently used in our analyses, evaluators derived overall ratings for each DRASTIC factor by weighting each rating category by the percent of the county falling in the corresponding range. Weighted ratings were totaled. All ratings are meant to reflect the vulnerability of the county's first potable aquifer.

Appendix table 1—Assigned weights for DRASTIC features

Feature	Regular weight	Pesticide weight
D = Depth to water table	5	5
R = Net recharge	4	4
A = Aquifer media	3	3
S = Soil media	2	5
T = Topography	1	3
I = Impact of the vadose zone	5	4
C = Hydraulic conductivity of the aquifer	3	2

Resources for the Future Pesticide Usage Data Base

Resources for the Future (RFF) has drawn together a variety of data sources to make pesticide application estimates for all States and counties in the United States.[18]

State usage survey data for 13 major crops in 33 States were assembled from the 1982 *Crop and Livestock Pesticide Usage Survey*, which was conducted by the Economic Research Service (ERS) and reported in Duffy (*21*) and other ERS publications. Other source material came from ERS reports covering national estimates of annual pesticide use for selected fruits, vegetables, potatoes, and citrus products (*23, 29, 50, 78*).

Annual pesticide use for all California crops was estimated from data contained in (*67*). Also, pesticide use by urban applicators and nurseries was estimated from survey results of the U.S. Environmental Protection Agency, Office of Pesticide Programs (OPP) (*57, 58*). All solvents, banned and minor chemicals, and undefined substances were excluded from the file, which left a total of 184 pesticides accounted for in the data base.

RFF carried out a number of extrapolations to account for pesticide applications in States not covered in available surveys. They are summarized below.

1. For the 33 States included in the ERS survey of 13 major crops, State crop pesticides use estimates were divided by the corresponding State's harvested crop acreage, as reported in the 1982 *Census of Agriculture*. Pesticide application coefficients (in terms of lbs/acre/year) from a nearby State were assigned to States not included in the ERS survey. By multiplying these coefficients by

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[18] See (*24*) for a complete description of the methodology.

Appendix table 2—DRASTIC factor ranges and ratings

DRASTIC factor	Range	Rating	Typical rating
Depth to water (feet)	0-5	10	
	5-10	9	
	15-30	7	
	30-50	5	
	50-75	3	
	75-100	2	
	100+	1	
Net recharge (inches)	0-2	1	
	2-4	3	
	4-7	6	
	7-10	8	
	10+	9	
Aquifer media	Massive shale	1-3	2
	Metamorphic/igneous	2-5	3
	Weathered metamorphic/ igneous	3-5	4
	Thin bedded sandstone, limestone, shale sequences	5-9	6
	Massive sandstone	4-9	6
	Massive limestone	4-9	6
	Sand and gravel	6-9	8
	Basalt	2-10	9
	Karst limestone	9-10	10
Soil media	Thin or absent	10	
	Gravel	10	
	Sand	9	
	Shrinking and/or aggregated clay	7	
	Sandy loam	6	
	Loam	5	
	Silty loam	4	
	Clay loam	3	
	Nonshrinking and nonaggregated clay	1	
Topography (Percent slope)	0-2	10	
	2-6	9	
	6-12	5	
	12-18	3	
	18+	1	
Impact of vadose zone media	Silt/clay	1-2	1
	Shale	2-5	3
	Limestone	2-7	6
	Sandstone	4-8	6
	Bedded limestone, sandstone, shale	4-8	6
	Sand and gravel with significant silt and clay	4-8	6
	Metamorphic/igneous	2-8	4
	Sand and gravel	6-9	8
	Basalt	2-10	9
	Karst limestone	8-10	10
Hydraulic conductivity (Gallons/day/ft^2)	1-100	1	
	100-300	2	
	300-700	4	
	700-1000	6	
	1000-2000	8	
	2000+	10	

Source: (4)

estimates of State harvested crop acreage, estimates of pesticide use for the 13 crops were obtained for all States that reported harvested. acreage in the *1982 Census of Agriculture*.

2. For applications to citrus fruits, pesticide application coefficients were derived from the ERS data on Florida, Arizona, and Texas. Applications to citrus crops in Louisiana were estimated using the derived Texas coefficients.
3. For the fruits and vegetables (including potatoes) included in the ERS surveys, national pesticide use coefficients were derived and applied to the State level. Total harvested acreage for each crop was used to derive total State application estimates.
4. For those crops included only in the California report (that is, onions, celery, cauliflower, carrots, cabbage, brussels sprouts, broccoli, lettuce, cantaloupes, cucumbers, green peas, snap peas, and watermelon), pesticide use coefficients were derived by crop. The coefficients were applied to other States based on the reported harvested acreages of those crops.
5. For the pesticide use of nurseries and urban applicators, the OPP national estimates were divided by the number of nurseries and single-unit housing structures, respectively, to yield pesticide use coefficients. The coefficients were then multiplied by the number of nurseries and single-unit housing structures, by State, to obtain estimates of Statewide applications for these categories.

Pesticide applications were estimated for a total of 76 crops (app. table 3). County-level estimates of pesticide applications on crops were obtained by prorating State-level estimates to the county level based on the number of harvested acres.

Appendix table 3—Crops for which pesticide applications are included in the RFF pesticide usage data base

Alfalfa
Almonds
Apples
Apricots
Artichokes
Asparagus
Avocados
Barley
Beets
Boysenberries
Broccoli
Brussels sprouts
Cabbages
Cantaloupes
Carrots
Cauliflower
Celery
Cherries
Citrus
Collard
Corn
Cotton
Cucumbers
Dates
Eggplants
Figs
Garlic
Grapefruits
Grapes
Green beans
Kale
Kiwi
Lemons
Lettuce
Melons
Mustard
Nectarines
Oats
Okra
Olives
Onions
Oranges
Other hay
Parsley
Pasture/range
Peaches
Peanuts
Pears
Peas
Pecans
Peppers
Persimmons
Pistachios
Plums
Pomegranates
Potatoes
Pumpkins
Radishes
Rice
Rye
Safflower
Sorghum
Soybeans
Spinach
Squash
Strawberries
Sugar beets
Sunflower
Sweet corn
Sweetpotatoes
Tobacco
Tomatoes
Turnips
Walnuts
Watermelons
Wheat

AGRICULTURAL CHEMICALS IN GROUND WATER:
PROPOSED PESTICIDES STRATEGY

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PESTICIDES AND TOXIC SUBSTANCES

DECEMBER 1987

TO THE READER:

This document contains the Environmental Protection Agency's proposed strategy for addressing the pesticides in ground water concern. The Agency is seeking public comment on the policies and approaches proposed in this document before developing a final strategy.

EPA's proposed strategy envisions national registration of pesticides with State- or county-wide restrictions based on ground-water concerns. EPA will also establish ground-water protection measures that will be uniformly applicable across the country. Still other management measures will be applicable only at sites with certain conditions (e.g., shallow water tables, location within wellhead protection areas).

EPA's registration decisions will be based on preventing unreasonable risks from ground-water contamination. The Agency proposes to use Maximum Contaminant Levels (MCLs), as established under the Safe Drinking Water Act, as reference points in helping determine the levels of ground-water contamination that would pose unreasonable risks if found in an underground source of drinking water. When MCLs are not yet available for certain pesticides, EPA proposes to use interim protection criteria, established by the Agency's drinking water health advisories, as its reference points. In addition to these reference points, a number of other factors will obviously need to be considered, including the benefits of a pesticide's use, when the Agency determines if a pesticide's potential to contaminate ground water poses an unreasonable risk. Nevertheless, these reference points will be important benchmarks for triggering reviews that will determine the need for pesticide management measures.

EPA's proposed strategy also provides interested and qualified States the opportunity to take the lead role in further refining the Agency's analysis and decisionmaking process. In this lead role, a State could tailor the conditions of pesticide use to specific local ground-water protection needs including such factors as hydrogeologic vulnerability which can vary greatly within counties. If appropriate, a State could permit use of certain pesticides in areas that EPA's registration decision would otherwise not allow. In such cases, EPA would modify the Federal registration to accommodate the State plan.

The Agency is particularly interested in receiving comments and recommendations on the following key issues regarding its strategy:

1. Determination of unreasonable health and environmental risks posed by pesticide contamination of ground water and the need for pesticide management measures to prevent such contamination.

    - Is it appropriate to use reference points, as described in the strategy, to trigger pesticide management measures? Are the risk levels represented by these reference points appropriate for this purpose? Would a range of levels, coupled with other considerations such as the extent of exposures, be more appropriate reference points?

    - Should different levels of protection be afforded ground-water resources based on whether they are a current or potential drinking water source? Should protection of potential drinking water differ depending on the degree of likelihood of future use? What factors should be considered when assessing the potential for a ground-water resource to be a future drinking water supply?

2. Roles and responsibilities of EPA and the States.

- What role should a State have in assessing and balancing pesticide risks and benefits when there are local ground-water concerns? Should a State have the responsibility for determining what ground waters will receive what level of protection?

- To what extent should EPA oversee a State's plan to manage pesticide use to protect its ground-water resources? Under what circumstances should EPA consider cancelling the use of a pesticide in a State even if that State has a plan to manage the pesticide?

- To what extent should EPA and the States concentrate on chemical-specific plans? Under what circumstances should a State undertake, and EPA accept, a generic plan for pesticides management in lieu of chemical-specific plans?

Reviewers should submit their comments on these and other issues raised by the Agency's proposed strategy to:

Ground Water Strategy Project
Office of Pesticides Programs
U.S. EPA (TS-766C)
401 M Street, S.W.
Washington, D.C. 20460

EPA has attempted to address the issues involving the pesticides in ground water concern as fully and as openly as possible. It is our hope that this document will elicit extensive public review and comment.

PREFACE

Pesticides contribute significantly to improved crop productivity and to public health by controlling a wide variety of pests. Each year, about 3.5 billion pounds of formulated pesticide products are used in this country to control harmful microorganisms, weeds, insects and rodents. While the benefits derived from the use of pesticides are considerable, these chemicals can also pose risks to human health and the environment.

There has been increasing concern for the potential risks posed by the detection of pesticides in ground water. Along with other Federal agencies and the States, EPA has initiated a number of efforts to better define this environmental concern. EPA has also undertaken the development of a strategy to ensure that the potential health and environmental impacts resulting from ground-water contamination are fully considered in pesticide registration decisions so that unreasonable risks can be identified and avoided. This document presents the Agency's proposed strategy for formal public review and comment.

Before reviewing this document, it is useful to understand four Agency tenets that form the underlying basis of the proposed strategy:

1) EPA considers the benefits as well as the risks of a pesticide's use. Congress recognized that the use of pesticides entails both risks and benefits when it established the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) as the basic law governing the use of pesticides in this country. Under FIFRA, EPA considers the benefits as well as the risks in the registration or licensing of a pesticide's use. In those circumstances where EPA determines that unreasonable risks are posed by a pesticide's use, the Agency takes steps to reduce the risks through regulatory action including, if necessary, cancelling or denying the registered use of a pesticide.

It is important to note that the mere presence of a pesticide residue in food, drinking water or the general environment does not necessarily present an unreasonable risk. The level of risk posed by pesticide residues is dependent upon the levels and duration of human exposures to residues of the pesticide and the toxicological significance of such exposures.

Once the potential risk posed by a pesticide's use is quantified, it must then be compared to the benefits derived from the use of the pesticide to determine if such risks are "unreasonable" as required by the FIFRA statute. However, prudent pesticide management requires the consideration of measures to minimize unnecessary exposures.

2) EPA pesticide registrations are national decisions that define the specific uses of individual pesticide products. For agricultural uses, a pesticide product must be registered for each specific type of crop on which the manufacturer or registrant intends it to be used. Historically, these registered uses of a pesticide and the conditions of their registration (e.g., rate, timing and method of application) have been uniformly applicable across the nation. A national basis for pesticide registration decisions has been found to be generally appropriate for addressing both unacceptable dietary and applicator risks.

Given the national food distribution system in this country, EPA generally employs average national exposure levels to assess and manage dietary risks to either the total population or certain sensitive subpopulations (e.g., infants). For applicator risks, the Agency employs a national approach because the two key factors in examining such exposures, the properties of a pesticide (i.e., toxicity and potential for dermal absorption or inhalation) and applicator practices (i.e., method of application and use of protective clothing), generally do not significantly vary with location. As described below and in the strategy, such national approaches to risk assessment and management may not be appropriate for addressing the pesticides in ground water concern.

3) EPA attempts to reduce net pesticide risk. While EPA's registration decisions are generally made on a chemical-by-chemical basis, the Agency attempts to assess the risks of a pesticide with the objective of net risk reduction for all pesticide use. As such, the Agency examines the risks and benefits posed by alternative pesticides and determines if there may be certain "risk-risk trade-offs," i.e., a decrease in the risks posed by one type of exposure results in an increase in risk through another type of exposure.

4) An exact assessment of the potential for "unreasonable risks" resulting from ground-water contamination would require consideration of a number of factors including: 1) local ground-water vulnerability; 2) the use and value of the local ground water; 3) resulting local health and economic impacts; and 4) the local benefits of the pesticide's use posing the potential risk. The vulnerability of ground water to pesticide contamination is dependent on a variety of site-specific factors including the hydrogeology of the area, the types and manner of pesticide use, and other farming practices, such as irrigation. The degree of risk posed by such contamination will depend on the local levels of contamination and the extent of human exposure. Finally, whether or not the risk is "unreasonable" will depend on the significance of the risk in the context of the benefits derived from the pesticide use.

As has been the case with certain pesticides, contamination of ground water can occur in numerous locations throughout the country. In some of these locations, agricultural production may be highly dependent on the use of a pesticide, and the risk of ground-water contamination may be considered reasonable particularly if the likelihood of significant exposures is minimal. In other circumstances, the benefits of a pesticide's use may be modest and ground-water contamination may be found to pose unreasonable risks particularly if there is the possibility for significant human exposures.

There are a number of additional considerations that should be included in an assessment of the local impacts of ground-water contamination. In some hydrogeologic settings, ground-water contamination may persist for years after a pesticide's use has stopped and thus, there is the potential for long-term exposures. Because of limited predictive capability and the high cost of monitoring, such exposures could remain undetected in some areas for long periods of time. It can be expensive for individual or local community well users to obtain alternative water supplies, effectively treat the water to reduce pesticide residues to acceptable levels, or restore the quality of ground water to acceptable levels. At the same time, however, the use of pesticides in these locations may be essential to the farmer's ability to grow crops.

Together, these four tenets raise a number of issues that the Agency must address in developing its strategy. The primary issue is how, and to what level of geographical refinement, the risks and benefits of a pesticide's use should be assessed when it has the potential to contaminate ground water. EPA's traditional way of assessing and managing national pesticide risks and benefits is not easily adapted to evaluating localized concerns. Unlike dietary and applicator pesticide exposures, the potential for exposures through ground-water contamination can vary widely across the country. From a national viewpoint, the number of people potentially exposed to pesticide residues through ground-water contamination is limited in comparison to dietary exposures. However, in those areas where ground-water contamination occurs, the local health and economic consequences can be substantial. Furthermore, in some cases, there is the possibility that a significant number of areas may experience such contamination for some time before it is detected.

(iv)
PROPOSED STRATEGY

How should EPA evaluate and weigh a pesticide's risks and benefits when the use of that chemical can result in ground-water contamination? What role should a State have in making these determinations and managing pesticides to avoid the problem?

As presented in this document, EPA's proposed strategy envisions the national registration of pesticides with county-wide or State-wide restrictions due to ground-water concerns. The risk-benefit determinations underlying these EPA-determined geographic prohibitions will be rather crude and dependent on the use of drinking water standards or health advisories and ground-water classification schemes as general points-of-reference. The proposed strategy, however, also offers each interested and qualified state the opportunity to take the lead role in further refining the Agency's analysis and decision-making process. In this lead role, a State could tailor the conditions of pesticide use to specific local ground-water protection needs. In some cases, a State might propose to allow the use of a pesticide in an area that EPA would otherwise not allow. A State could employ land use planning and ground-water classification in addition to specific hydrogeologic and crop use patterns to refine pesticide management decisions. Where found appropriate, EPA would consider modifying the Federal registration to accommodate the state program.

A wide range of agricultural ground-water experts, including managers and scientists from Federal and State agencies, and representatives from farm, industry and environmental interest groups, and research and educational institutions, were consulted as the Agency undertook the development of this proposed strategy. The Agency held a major workshop in the summer of 1986 with these experts to solicit their opinions and recommendations. The Agency also talked extensively with the members of Congress and their staffs on approaches to this environmental issue. The Agency developed a draft proposal and invited the participants from the previous workshop, along with Congressional staff and additional State representatives to review the proposal in a second workshop held last summer. At this time, EPA is seeking broad public comment on the policies and approaches of this proposed Agency strategy.

PROPOSED STRATEGY

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EXECUTIVE SUMMARY

This document presents EPA's proposed strategic plan for protecting ground water from contamination by pesticides. It is divided into three parts: (1) a brief summary assessment of the problem; (2) the proposed Agency strategy; and (3) an outline of implementation issues and questions. At this time, EPA is seeking comments on all three parts of the document, including: the findings and assumptions of the summary problem assessment; the proposed policies and programs of the Agency's pesticides strategy; and the implementation questions and issues raised by the Agency's proposed strategic approach.

SUMMARY PROBLEM ASSESSMENT

Ground water is a valuable national resource which can be vulnerable to contamination by pesticides from normal agricultural use as well as from leaks, spills and disposal. Although the full extent of the problem is not known, enough information has been reported to indicate that the problem is widespread in certain areas of the country. Most findings of pesticides in ground water have been at relatively low levels, although some significant levels have been reported in some areas, resulting in numerous well closings. The full scope of the health and environmental effects associated with pesticides in ground water remains unclear at this time and may not be known for several years. What is clear, however, is that once widespread contamination of ground water by pesticides has occurred, it is often not economically or technically feasible to restore the resource. Even provisions of alternative drinking water or treatment to remove contamination from drinking water before it is used may be impracticable if contamination is widespread. For these reasons, prevention of unacceptable contamination must be the primary focus of protection efforts.

The potential vulnerability of ground water to pesticide contamination is determined by a complex set of factors which vary significantly from area to area. Furthermore, the use and value of ground waters vary considerably across the country. In some areas, ground water provides an irreplaceable source of drinking water for large populations, while in other areas, ground water is essentially unusable. These highly variable characteristics of the ground-water resource and the area-specific nature of the pesticide contamination concern suggest the need for a localized protection approach.

The number and complexity of Federal and State programs and statutory authorities which may be used to address the pesticides in ground-water concern is substantial. Currently, EPA administers five major environmental statutes that address some aspect of pesticide contamination in ground water, including the:

- Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)
- Safe Drinking Water Act (SDWA)
- Clean Water Act (CWA)
- Resource Conservation and Recovery Act (RCRA);
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

In addition to EPA, other Federal agencies, such as the U.S. Department of Agriculture (USDA) and the U.S. Geological Survey (USGS) of the Department of Interior, are key institutions in addressing this issue. And just as important, the States have a major role to play in addressing ground-water contamination. Here again, at the State level a number of different agencies and statutes are involved in the protection of ground water and pesticides management. A number of States have already taken aggressive action in dealing with the concern for ground-water contamination by pesticides.

Protection of ground water from pesticide contamination will require a coordinated approach among these Federal and State agencies. Development of a comprehensive strategy is one of the first steps needed in moving toward an integrated and successful management approach.

2
PROPOSED STRATEGY

PESTICIDES STRATEGY

The purpose of the strategy is to articulate EPA's long-term approach for managing the pesticides in ground-water concern. The proposed strategy is organized into three chapters that address the key issues associated with: the Agency's environmental goal; its prevention strategy; and its response strategy. Each of these chapters first describes the factors and options which EPA considered, followed by a detailed description of the Agency's proposed policy choices. The Agency made its policy choices based on consideration of its legislative statutes, its long-term policies for pesticides registration, and its general Ground-Water Protection Strategy (1984).

Environmental Goal: EPA's environmental goal will be to manage the use of pesticides to protect the ground-water resource. Specific attention will be given to preventing unacceptable contamination of current and potential drinking water supplies. The Agency will use MCLs or other EPA-designated protection criteria as reference points for helping to determine unacceptable contamination of ground water. Specifically, the Agency will adopt the following policies as its environmental goal for protecting ground water from pesticide contamination:

1. The Agency will use a differential protection approach to protect the ground-water resource. With this approach, the Agency will apply protective efforts to those waters that are a current or potential source of drinking water or that are vital to fragile ecosystems. Additional measures may be taken to ensure protection of certain "high priority ground waters."

2. EPA will use MCLs, as defined under the SDWA, as reference points for helping to determine unacceptable contamination of ground water that is a drinking water source. When no MCL exists, EPA will use interim drinking water protection criteria as its reference points. These will be equivalent to an MCLG for noncarcinogenic pesticides and to a

negligible risk level for carcinogenic pesticides. The Agency will also use ecologically based protection criteria as reference points for helping to determine unacceptable ground-water contamination.

Prevention Policy and Program: The Agency's proposed strategy to prevent unacceptable pesticide contamination of ground water will be based on a multipronged management approach with varied Federal-State roles. Specifically, EPA's prevention strategy will consist of the following policies:

1. EPA will continue to take uniform action for pesticides posing widespread, national concerns and will establish generic prevention measures to address certain pesticide use and disposal practices that pose unique ground-water threats independent of local vulnerability.

2. EPA will also adopt a new approach of differential management of pesticide use based on differences in ground-water use, value and vulnerability to an extent that is administratively feasible. County-level or State-level measures, based on ground-water vulnerability, will be employed including use cancellations. In some cases, the user will have to determine the applicability of differential prevention measures based on local field conditions or the user's location in an area of "high priority ground waters" (i.e., high use and value ground waters).

3. EPA will encourage the development of a strong State role in local management of pesticide use to protect the ground-water resource. State pesticide management plans will be used to strengthen EPA's foundation for pesticide registration decisions. In some cases, the registered use of a pesticide in a State will depend on the presence and adequacy of such a State management plan. Under a management plan, a State will have the opportunity to develop and implement highly tailored prevention measures based on area-specific differences in ground-water use, value and vulnerability.

4. The user's role in preventing ground-water contamination is pivitol; users will be provided with better information and training to enable them to make environmentally sound decisions.

5. Registrant responsibilities will need to increase in three areas: (1) technical support of the user in the field; (2) ground-water monitoring to ensure the adequacy of pesticide management plans in protecting ground water; and (3) the development of safer alternative pesticides.

6. Increased monitoring of pesticides in ground waters is critical to the implementation of this strategy. EPA will establish an "early-warning" or "yellow light/red light" approach to prevent further area contamination once it is detected. Under this system, MCLs or other EPA-specified protection criteria will be used as reference points to evaluate, and when necessary, change pesticide management plans.

Response Policy and Program: The Agency's policy for responding to pesticide contamination of ground water emphasizes Federal-State coordination and statutory enforcement activities. More specifically, these policies include:

1. Where a pesticide has reached unacceptable levels in ground water, strong actions are to be taken to stop further contamination. These actions can range from enforcement measures to modification of the way a pesticide is managed, including geographic restrictions of the pesticide's use.

2. EPA will encourage a strong State role in responding to contamination. A State's management plan should consider the development of a valid corrective response scheme.

3. EPA will continue to develop and emphasize enforcement of MCLs to protect users of public drinking water systems. Under SDWA's emergency powers, EPA will consider issuing orders requiring responsible parties to provide alternative water supplies when levels of pesticides present an imminent and substantial endangerment to public health.

4. EPA and the States will place greater emphasis on coordinating FIFRA, SDWA, and CERCLA enforcement activities to identify parties responsible for ground-water contamination as a result of the misuse of pesticides, including illegal disposal or leaks and spills.

5. On a case-by-case basis, EPA may assist States by undertaking CERCLA Fund financed removal actions to provide alternative drinking water supplies where there is an imminent human health threat.

6. The question of who should pay for corrective actions at sites contaminated by the approved use of a pesticide is a legislative question. EPA believes that several aspects of the problem must be considered before a decision can be made.

IMPLEMENTATION ISSUES

The final part of this document puts forth a number of implementation issues and questions raised by the proposed pesticide strategy. The Agency is particularly interested in receiving input on these issues before finalizing its strategy and initiating the development of an implementation plan. To reflect the presentation of the pesticide strategy, this part of the document is also arranged into three chapters covering the implementation issues associated with the Agency's proposed policies for its environmental goal, prevention strategy and response strategy.

Environmental Goal: The key implementation issues underlying EPA's goal are:

1. What definition and process should be used to identify ground waters as potential drinking water sources that require baseline protection?

2. What definition and process should be used to identify "high priority ground waters"?

Prevention Policy and Program: There are six key areas of implementation issues raised by EPA's prevention policy and program:

1. Generic national control measures;
2. Barriers to implementing a differential approach;
3. State management plan - criteria, EPA oversight, and support.
4. Support of user decisionmaking;
5. Research and development priorities; and
6. Monitoring/early-warning system - mechanism and criteria.

Response Policy and Program: EPA identified the following four key implementation issues arising from its proposed response program:

1. Under what circumstances should EPA consider not registering a pesticide in a State that does not have a corrective action scheme?

2. What indirect EPA responses, including technical assistance to the States or national public information and educational efforts, should be a priority for development?

3. What can be done to facilitate coordination of enforcement activities under FIFRA, RCRA, SDWA, and CERCLA to identify parties responsible for contamination resulting from misuse, such as illegal disposal or leaks and spills? and,

4. When should EPA consider assisting a state under the Agency's CERCLA removal program? What should be the criteria for defining an imminent health threat resulting from pesticide contamination of drinking water?

PART I

PROBLEM ASSESSMENT SUMMARY

INTRODUCTION

The purpose of this first part of the document is to provide a brief summary assessment of the pesticides in ground-water concern. This assessment highlights the basic characteristic of the problem which EPA considered in developing its proposed strategy. A more detailed description of the problem can be found in the background documents and strategies listed in Table I-1.

Table I-1

Examples of Key Reports on the Ground Water Problem and Recommended Strategies

1. ***Ground-Water Protection Strategy***
   U.S. Environmental Protection Agency
   Office of Ground-Water Protection
   (EPA, 1984)
2. ***Pesticides in Ground Water: A Background Document***
   U.S. Environmental Protection Agency
   Office of Ground-Water Protection
   (EPA, 1986)
3. ***Improved Protection of Water Resources from Long-Term and Cumulative Pollution: Prevention of Ground Water Contamination in the U.S.***
   U.S. Environmental Protection Agency
   Office of Ground-Water Protection
   (EPA, 1987) (Prepared for OECD)
4. ***Protecting the Nation's Groundwater from Contamination***
   Office of Technology Assessment
   U.S. Congress
   (Washington, D.C., 1984)
5. ***Ground-Water Quality Protection: State and Local Strategies***
   National Research Council
   Washington, D.C., 1986)
6. ***Agricultural Effects on Groundwater Quality***
   Congressional Research Service
   U.S. Congress
   (Washington, D.C., 1986)
7. ***A Congressional Agenda to Prevent Groundwater Contamination: Building Capacity to Meet Protection Needs***
   Environmental and Energy Study Institute
   (Washington, D.C., 1986)
8. ***Groundwater Protection: Saving the Unseen Resource***
   The Conservation Foundation
   (Washington, D.C., 1987)
9. ***The Leaching Fields: A Nonpoint Threat to Groundwater***
   California Assembly Office of Research
   (California, 1985)
10. ***Groundwater Contamination in the U.S.***
    Pye, Patrick, et al
    (Philadelphia, 1983)

CHAPTER 1
GROUND WATER: THE RESOURCE

1. Use and Value of Ground Water

Ground water is a critical national resource which provides about one-fourth of all the water used in the United States. It is the source of drinking water for nearly half of the total United States population, and in rural areas ground water may be the only, or at least the dominant, source of drinking water. In eight states, 90% or more of the entire state population depends on ground water for their domestic water supply (Table I-2).

By volume, irrigation consumes the largest amount of ground water, accounting for about two-thirds of ground-water withdrawals in 1975. As shown in Figure I-1, withdrawals of ground water nearly tripled between 1950 and 1980, reaching 88 billion gallons per day in 1980. In addition to meeting the nation's demand for water, ground water plays an important environmental function. For example, ground water provides recharge to surface streams and sustains aquatic wetlands and terrestrial ecosystems. In coastal areas, ground water helps prevent saltwater intrusion into potable water supplies.

2. The Nature of Ground Water

Ground water is found within the earth in geological formations called aquifers (Figure I-2). Vertical geological profiles of ground-water systems are divided into different zones. The uppermost zone is called the unsaturated zone, and by definition does not contain enough water to enable a well drilled into this zone to yield usable quantities. The properties of the unsaturated zone, however, control the extent of recharge of water from the land surface to the saturated zones below. The extent of recharge to an aquifer can be thought of as a balance between infiltration or percolation of water down through the unsaturated zone and horizontal runoff on the land surface, or return of moisture to the atmosphere by evapotranspiration. The properties of the land surface and unsaturated zone material that control recharge include the slope, extent of vegetation cover, thickness of the

Table I–2

Percentages Of People Relying On Ground Water For Domestic Use

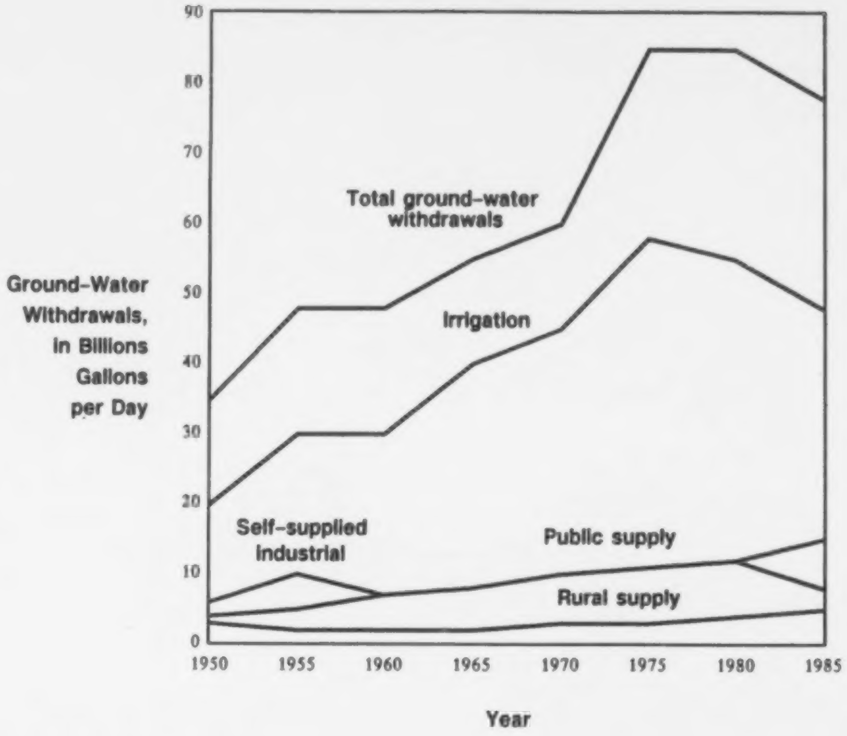
States	Percent of State Population
Arizona, Florida, Hawaii, Idaho, Mississippi, Nebraska, Nevada, New Mexico	Over 90
South Dakota	80 – 89
Delaware, Iowa, Maine	70 – 79
Alaska, Indiana, Kansas, South Carolina, Washington, Wisconsin, Utah	60 – 69
Arkansas, California, Illinois, Louisiana, Michigan, Montana, New Hampshire, North Dakota, Tennessee, Texas, Vermont, West Virginia, Wyoming	50 – 59
Georgia, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Virginia	40 – 49
Alabama, Connecticut, Massachusetts, Missouri, North Carolina, Oklahoma, Oregon	30 – 39
Colorado, Kentucky, Rhode Island	20 – 29
Maryland, Puerto Rico, Virgin Islands	Under 20

Note: For the purpose of this report, Puerto Rico and the Virgin Islands are treated as states in this table and all following tables. The information for these tables has been developed from Volume II of this report

Source: State Ground Water Program Summaries, Office of Ground Water Protection, EPA, March 1985

Figure I-1

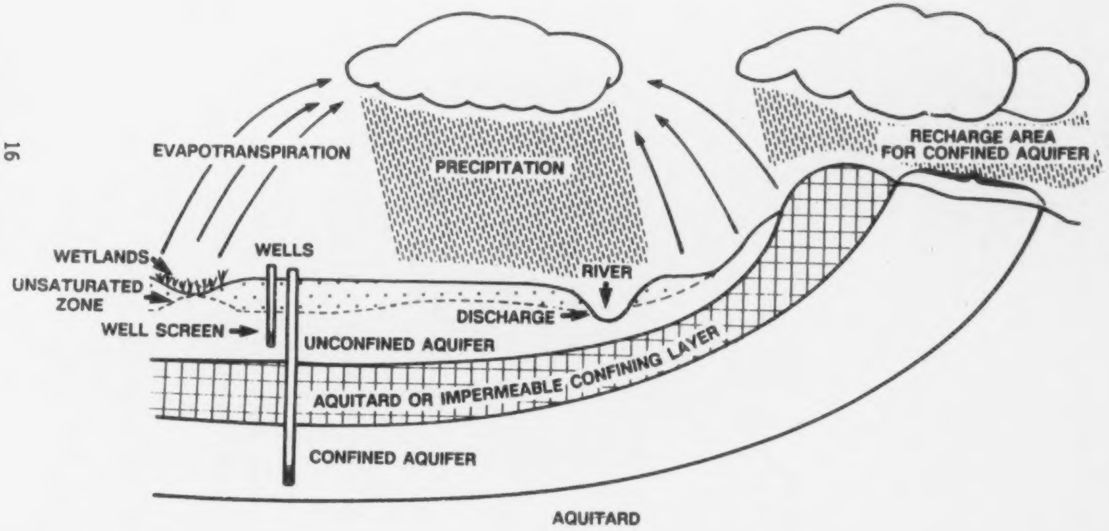
Trends in Ground-Water Withdrawals
1950–1985



Source: U.S. Geological Survey
Cited in: Improved Protection of Water Resources From Long-Term and Cumulative Protection, EPA, 1987

Figure I–2

Illustration of Relationships Within the Hydrologic System


EVAPOTRANSPIRATION
PRECIPITATION
RECHARGE AREA FOR CONFINED AQUIFER
WETLANDS
WELLS
UNSATURATED ZONE
RIVER
DISCHARGE
WELL SCREEN
UNCONFINED AQUIFER
AQUITARD OR IMPERMEABLE CONFINING LAYER
CONFINED AQUIFER
AQUITARD

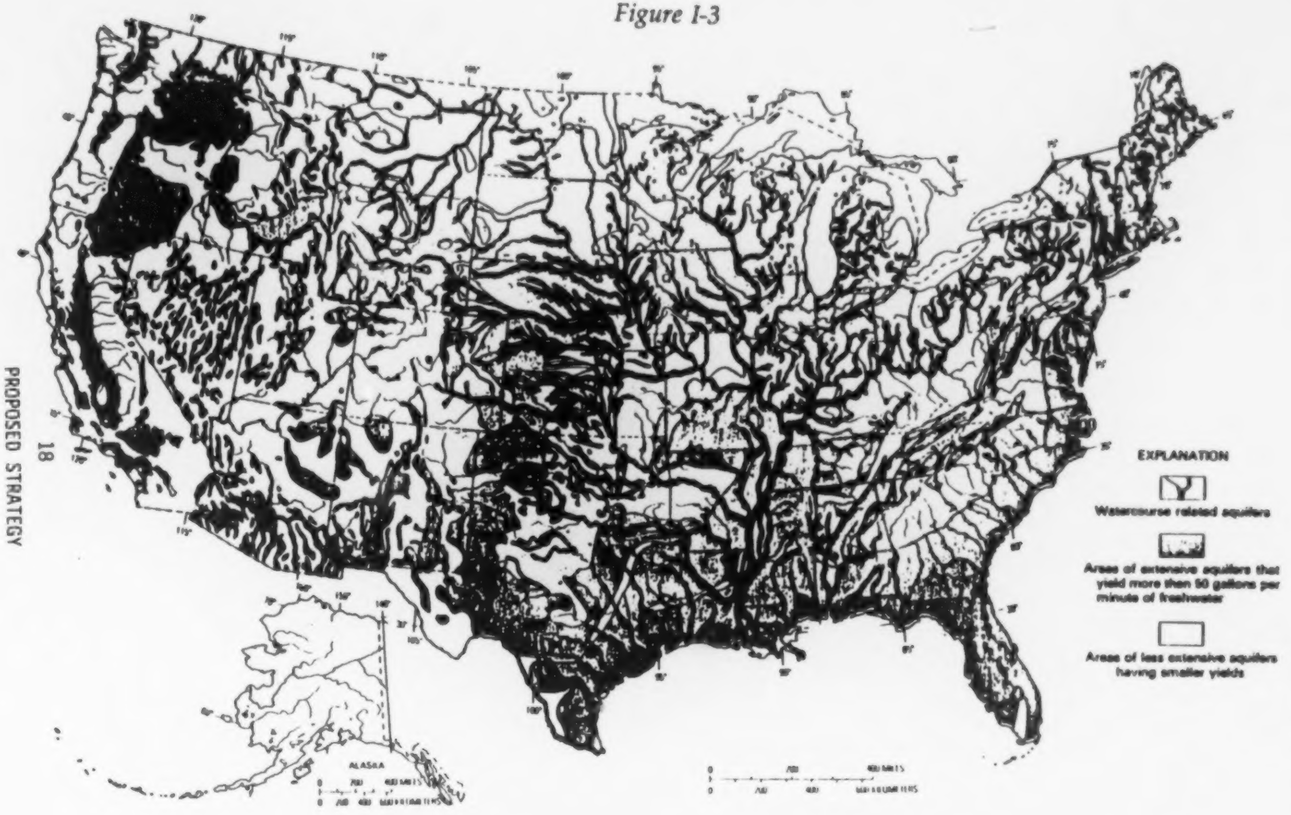
unsaturated zone, the inherent capabilities of the unsaturated zone materials to conduct water, and the presence of cracks or fractures in the zone.

The saturated zone is the aquifer. It is the geological zone from which water may be obtained by pumping. Often there may be several aquifers in a geological profile (Figure I-2), separated by layers of less permeable rock and clay. The boundary between the unsaturated zone and the uppermost aquifer is called the water table; the water in this area is an unconfined, or water table aquifer. Surface water can enter such an aquifer through percolation. The lower aquifer in Figure I-2 is a confined aquifer; the entry point or recharge zone for water to reach this aquifer may be far away from the point of withdrawal. Even when aquifers appear to be separated from one another as shown in Figure I-2, they may be connected through interruptions or fractures in the intervening layers.

The characteristics of aquifers can vary greatly in area, depth below the land surface, volume of water stored, permeability, interconnectedness, and velocity of flow. Some aquifers underlie only small local areas, while others span thousands of square miles and cross several State boundaries. Usable aquifers are found almost everywhere in the United States (Figure I-3). Water is recharged to, or enters, aquifers by percolation from rainfall, snow-melt and runoff, or has been trapped in aquifers since geologic time. Many aquifers may also have natural discharge areas, such as springs, marshes, or stream-beds. It has been estimated that about 30% of the flows in streams and rivers during an average year is provided by ground-water discharge.

The rate of ground-water movement through an aquifer depends largely on the permeability of the aquifer. In a uniform aquifer, the velocity of the ground-water movement may range from 1 meter/year to 1,000 m/yr, with the most common rate being between 10-100m/yr. Slow rates of movement can prevent contaminants from spreading or mixing rapidly, concentrating them in slow-moving plumes that may remain undetected for long periods of time. Such time lags could result in contamination being found long after the source of contamination has been effectively removed.

Figure I-3


EXPLANATION
Watercourse related aquifers
Areas of extensive aquifers that yield more than 50 gallons per minute of freshwater
Areas of less extensive aquifers having smaller yields
ALASKA
0 200 400 MILES
0 200 400 600 KILOMETERS

PRODUCTIVE AQUIFERS AND WITHDRAWALS

FROM WELLS IN THE UNITED STATES

An aquifer's permeability is determined largely by the types of solid materials or geological formation of the aquifer. In some areas, the aquifer may consist of fine sand or include significant amounts of silt and clay and thus have a much lower permeability.

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PROPOSED STRATEGY

CHAPTER 2
PESTICIDES IN GROUND WATER: THE CONCERN

1. Extent of Contamination

Until a few years ago, most people believed that ground water was protected from contamination by soil and rock formations. This general belief began to change in the late 1970's with the findings of chemicals in a number of wells across the country. In 1979, two pesticides were discovered in ground water: dibromochloropropane (DBCP) in California and aldicarb in New York. Additional monitoring in other States shortly thereafter showed DBCP in ground water in Arizona, Hawaii, Maryland, and South Carolina; and aldicarb was found in Wisconsin in 1980.

Perhaps the most serious case of pesticide contamination of ground water was the discovery in 1982 of ethylene dibromide (EDB) in two California wells and in three wells in Georgia. By the end of 1983, EDB contamination of ground water had been discovered in 16 different counties in California, Florida, Georgia, and Hawaii. These findings caused EPA to issue an immediate suspension of all EDB soil uses in September 1983.

Until the discovery of pesticides in ground water, Federal and State agencies did not monitor ground water for these chemicals. There were several reasons: most ground-water monitoring until that time focused on urban rather than rural agricultural areas; analyses of water were usually for volatile organic contaminants, while most pesticides have low volatility; and reports of positive findings of organic contaminants did not always distinguish between surface and ground-water systems.

The discovery of DBCP, aldicarb, and EDB in certain areas of the country stimulated a number of monitoring activities by Federal and State agencies to investigate the extent of the problem. By 1986, a total of 19 different pesticides had been detected in ground water in 24 States where the source of the contaminant was most probably a result of agricultural application (nonpoint source) rather than from spills or other point sources of the pesticides (Table I-3 and Figure I-4). It is important to note that ground-water contamination resulting from normal pesticide use applications may occur over large geographical areas and result in exposure to large segments of the population.

Some of the more important findings from recent State monitoring efforts are as follows:

- California: Approximately 57 different pesticides have been detected in California's ground waters; one-half of these were attributed to point sources (leaks and spills) rather than normal pesticide application. Nearly 2500 drinking water wells were found to contain DBCP; about 60% of these had levels above the State standard of 1 part per billion (ppb). About 700,000 people may have been exposed to DBCP via drinking water as a result.
- Hawaii: Thirteen public drinking water wells have been found to be contaminated by EDB, DBCP, and/or trichloropropane; these wells serve more than 130,000 people.
- Florida: EDB has been found in about 10% of public and private drinking water wells serving more than 50,000 people. About 1,200 wells have been closed.
- New York: On Long Island, almost 2,000 wells were found to contain aldicarb; about 50% of these wells had levels which were above the New York State standard of 7 ppb.
- Minnesota: Separate surveys of private and public drinking water wells have been conducted recently. In 1986, one or more pesticides were detected in 52% of 225 private wells; and in an ongoing survey of public wells, one or more pesticides have been detected in 29% of 366 wells sampled. The average concentrations of pesticides found in these wells were below the State health standards.
- Iowa: Nine herbicides and two insecticides have been detected in monitoring studies conducted in Iowa. For the most part, concentrations were less than one part per billion; the major source of these pesticides were attributed to normal agricultural application. Monitoring data indicate that about 27% of the population consumes drinking water which contains low concentrations of pesticides.

While all of the above State surveys have expanded our knowledge of pesticide contamination of ground water, they cannot be assembled into a valid national estimate of the extent of ground-water contamination. Many of these State surveys have been conducted in areas where contamination was already

Table I-3

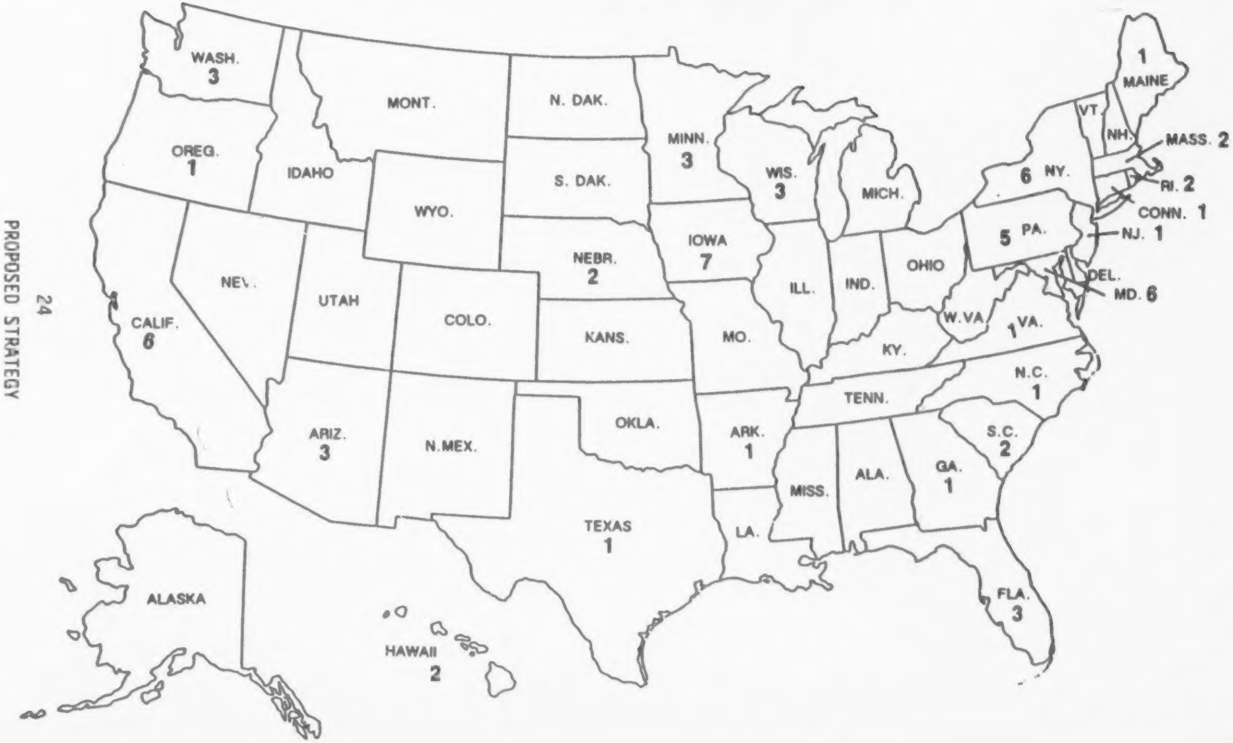
Pesticides Found In Ground Waters Of 24 States

PESTICIDE	USE*	STATE	TYPICAL POSITIVE ppb*
Alachlor	H	MD, IA, NE, PA, MN	0.1 - 10
Aldicarb (sulfoxide & sulfone)	I, N	AR, AZ, CA, FL, MA, ME, NC, NJ, NY, OR, RI, TX, VA, WA, WI	1 - 50
Atrazine	H	PA, IA, NE, WI, MD, MN	0.3 - 3
Bromacil	H	FL	300
Carbofuran	I, N	NY, WI, MD	1 - 50
Cyanazine	H	IA, PA, MN	0.1 - 1.0
DBCP	N	AZ, CA, HI, MD, SC	0.02 - 20
DCPA (and acid products)	H	NY	50 - 700
Dicamba	H	IA, MN	0.1 - 2
1, 2 - Dichloropropane	N	CA, MD, NY, WA	1 - 50
Dinoseb	H	NY	1 - 5
EDB	N	CA, FL, GA, SC, WA, AZ, MA, CT	0.05 - 20
Fonofos	I	IA	0.1
Metolachlor	H	IA, PA, MN	0.1 - 0.4
Metribuzin	H	IA	1.0 - 4.3
Oxamyl	I, N	NY, RI	5 - 65
Propachlor	H	MN	0.2 - 0.5
Symazine	H	CA, PA, MD, MN	0.2 - 3.0
1, 2, 3 - Trichloropropane	N (impurity)	CA, HI	0.1 - 5.0

*H = herbicide; I = insecticide; N = nematicide
**ppb = parts per billion; 1 ppb = 1/1000 ppm; 1 ppm = 1 mg/l

Figure I-4

Numbers of Pesticides Found in Ground Water As a Result of Agricultural Practice


WASH. 3
OREG. 1
CALIF. 6
IDAHO
NEV.
MONT.
WYO.
UTAH
ARIZ. 3
COLO.
N.MEX.
N. DAK.
S. DAK.
NEBR. 2
KANS.
OKLA.
TEXAS 1
MINN. 3
IOWA 7
MO.
ARK. 1
LA.
WIS. 3
ILL.
MISS.
MICH.
IND.
KY.
TENN.
ALA.
OHIO
W.VA.
1 VA.
N.C. 1
S.C. 2
GA. 1
FLA. 3
6 NY.
5 PA.
1 MAINE
VT.
NH.
MASS. 2
RI. 2
CONN. 1
NJ. 1
DEL.
MD. 6
ALASKA
HAWAII 2

known to exist and have been conducted for different purposes and according to different design strategies. In order to get a better handle on the extent of the problem, EPA has initiated a comprehensive statistically based survey of drinking water wells across the country. Results from this survey are expected to be available in 1989.

2. Potential Health Effects

The health effects of chemicals can be divided generally into two classes: acute effects and chronic effects. Acute effects result from contact with high levels of a chemical over a short period of time; chronic effects generally occur as a result of long-term exposure to low levels of a chemical. Acute effects, such as nausea, skin irritation, etc., are usually easier to identify because they occur soon after exposure. Chronic effects, on the other hand, are harder to document, particularly because of the long time interval between exposure and outcome.

Generally, concentrations of pesticides in ground water have been found at low levels, and therefore most of the concern has been focused on the potential for chronic effects, such as cancer, mutations, birth defects, and immunological changes. However, there are many gaps in our information about chronic effects of pesticides in ground water. Although the toxicity and general chronic effects for certain pesticides may be known, it is difficult to associate a health problem due to exposure to the chemicals in drinking water. Assessing the risk posed by a pesticide in ground water involves knowing the precise combination of hazard and the duration and intensity of exposure. Furthermore, the risk can be complicated by a combination of several factors such as degradation processes, routes of exposure, and the effects of other chemicals in the ground water.

Health risk assessments are a fundamental tool used by EPA programs to characterize the potential for harm to human health by chemical substances in the environment. These assessments form a key part of the basis upon which policy makers determine whether, and to what extent, measures to reduce risks are warranted.

EPA's method of risk assessment for potential ground-water contaminants is based on a four-part process which includes: (1) hazard identification, (2) dose-response evaluation, (3) human exposure evaluation and (4) risk characterization. With respect to pesticides in ground water, EPA carries out several risk assessment activities. One of the Agency's more recent risk assessment activities has been the development of health advisories (HA's) for 60 known or potential leaching pesticides. These health advisories describe the concentrations of contaminants in drinking water at which adverse effects are expected to occur. In the near future, the Agency expects to develop enforceable standards or maximum contaminant levels (MCLs) for pesticides in drinking water.

3. Costs of Contamination

Measuring the costs to society from chemicals in ground water is a difficult task. Some economists have estimated the costs and benefits of ground-water contamination policies using a "damages avoided" framework on a site-by-site basis. However, this approach has certain limitations, namely that it may not be applicable to a national analysis. Another way to estimate what society must pay to reduce a contamination risk is to appraise the avoidance costs. A USDA report by Nielson and Lee, 1987, employed this approach. In this report, the authors estimated that the costs of avoiding risks imposed by ground-water contamination by pesticides are potentially significant. Monitoring costs were the major expense for households, ranging from $0.9 to $2.2 billion, with $1.4 billion being the "best" estimate.

The other major expense for households seeking to avoid risks from pesticides in their drinking water was the cost of responding to contamination. Installing home-water treatment units or providing alternative drinking water supplies are possible options, but the costs can vary significantly, depending on the system used and the size and location of the area covered. Although national estimates are not possible to develop, data do suggest that these types of actions could result in substantial costs, particularly to small communities and private well owners.

Another option for responding to pesticide contamination of ground water is to clean up or contain a contaminated aquifer. Containment or clean-up techniques are much more expensive than the previous options and may be economically feasible only for point source contamination, e.g., leaks and spills. Cleaning up widespread nonpoint sources of contamination from pesticide application would be even more expensive and may not be technologically or economically feasible for most areas. The estimated cost of cleaning up a hazardous waste site that involves ground-water pumping and installation of a cutoff wall ranges from $1.9 million to $6.1 million, depending on the volume of ground water pumped.

In addition to these direct costs associated with preventing and responding to contamination of ground water, there are a number of other indirect costs that society may face. For example, ground-water contamination could result in crop loss and a decline in property values as well as increased medical costs and the costs of possible law suits.

Because of these problems associated with the potential high costs and technical complexity of responding to ground-water contamination by pesticides, there is clearly a role for effective Federal and State management strategies to prevent contamination.

CHAPTER 3

PESTICIDES IN GROUND WATER: CAUSATIVE FACTORS

An effective prevention strategy must consider the complex set of factors which determine the likelihood of a pesticide reaching ground water. The factors and their interactions vary greatly depending on specific local conditions and circumstances. For this reason, the problem of pesticides in ground water, although a national concern, must be addressed at a more localized level. The following discussion outlines the set of factors which affects ground-water contamination. These factors have been grouped into four major areas: sources of contamination, chemical-physical characteristics of the pesticide, ground-water vulnerability and agricultural practices.

1. Sources

Ground water may become contaminated by pesticides at any point in their use cycle (Table I-4): during manufacture, distribution in commerce, storage, use on the land or in industrial settings, or disposal. These sources of potential contamination may be grouped together into two categories based on the characteristic of the contamination potential and on the types of actions that may be taken to prevent contamination.

The first category includes accidental spills and leaks of pesticides at manufacturing facilities or distribution points such as agricultural chemical dealerships or commercial applicator facilities, where bulk chemicals are stored and handled. Also included in this category are places, including hazardous and municipal waste landfills and other waste handling or treatment facilities, where chemical wastes are disposed of. Ground-water contamination resulting from leaks and spills generally result in plumes that are relatively localized. The origin of such "point source" contamination may be prevented, and clean-up using available techniques may be possible.

The much larger second category of sources is application of pesticides to crops, rangeland, forests and rights-of-way. When pesticides are applied to the land, they are carried above, across, and through the ground by wind,

Table 1-4

Potential Sources of Pesticide Contamination of Ground Water

	Manufacturers/ Formulators	Dealer	Industrial User	Land Application
SPILLS AND LEAKS				
Storage Areas	x	x	x	x
Storage Tanks/ Pipelines	x	x	x	x
Loading/Unloading	x	x	x	x
Transport Accidents	x	x	x	x
DISPOSAL				
Process Waste	x		x	
Off-specification material	x			
Cancelled Products	x	x	x	x
Containers	x	x	x	x
Rinsate			x	x
LAND APPLICATION				x
Leaching				x
Backflow to Irrigation Well				x
Run-in to Wells, Sinkholes				x
Mixing/loading areas				x
Feed Lots				x

rainfall, runoff, and infiltration. Pesticides dissolved in runoff water are carried to nearby surface water or may enter ground water through direct infiltration at the point of application or after traveling via the surface or through soil to ditches or other runoff retention areas. They may also reach ground water through sinkholes or poorly constructed well casings or abandoned wells.

Of the 1.1 billion pounds of pesticide chemicals used in 1984, 77% or 861 million pounds were used in agriculture, with the rest used by industry, government, and home and garden users. There are about 600 actual pesticide chemicals in common use, and these are formulated into over 45,000 individual products. Important types of pesticides include insecticides, herbicides, fungicides, plant growth regulators and rodenticides. Herbicides form the largest use class, as shown in Table I-5. They are also the most rapidly growing class (Figure I-5): applications of herbicides now account for nearly 90% of the acreage of all major crops treated. For pesticides as a whole, six crops (alfalfa, corn, cotton, sorghum, soybeans, and wheat) account for about 90% of all acre-treatments. This concentration of pesticide use on a few major crops means that the application is heavily concentrated in certain major agricultural areas, such as the upper Midwest of the U.S.

2. Physical-Chemical Properties

Not all pesticides are equal in their ability to reach ground water. Just as there are great variations in the natural vulnerability of ground water to contamination, there are great variations in the chemical properties of pesticides which control their tendency to leach to ground water. Although ground-water contamination by pesticides is a relatively recent public concern, research on the environmental fate of pesticides in soil over the last two decades has provided a general understanding of the pesticide properties and environmental conditions which together determine the potential for a pesticide to reach ground water.

Table I-5

Volume of U.S. Pesticides Used, by Class and Sector
1985 Estimates

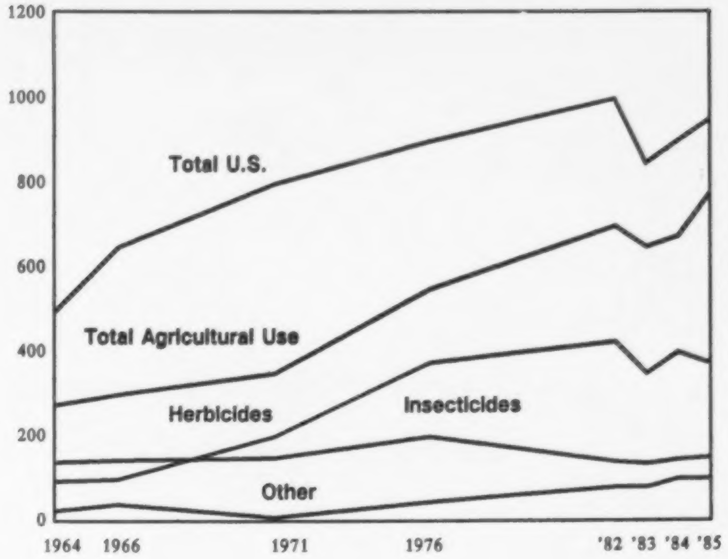
	(millions of pounds of active ingredients)				
	Herbicides[1]	**Insecticides**[2]	**Fungicides**[3]	**Other**[4]	**Total**
Agriculture	**525**	**225**	**51**	**60**	**861.0**
Ind./Comm./Govt.	**115**	**40**	**21**	**.1**	**176.1**
Home & Garden	**30**	**35**	**12**	**.1**	**75.1**
Total	**670**	**300**	**84**	**60.2**	**1112.2**

Source: EPA Estimates from the Office of Pesticides Program, Economic Analysis Branch.

[1] Includes plant growth regulators.
[2] Includes miticides and contract nematicides.
[3] Does not include wood preservatives.
[4] Includes rodenticides, fumigants, and molluscides.

Figure I-5

U.S. Pesticide Total Use and Estimated Sector and Class Shares 1964–1984



Source: EPA Estimates from the Office of Pesticide Programs, Economic Analysis Branch.

Note: Excludes wood preservatives, disinfectants, and sulfur.

*Revised 1982 numbers.

No single property of a pesticide chemical uniquely determines its potential to leach; rather, the interaction of several independent properties governs leaching behavior. Tests for these properties are required for registration of all pesticides used on crops. The properties include:

- water solubility: the propensity for a pesticide to dissolve in water. Pesticides with water solubility can more easily be carried in solution in water percolating down to the water table. Solubility of greater than about 30 parts per million has been selected as a "flag," indicating a pesticide with a high potential to leach (Cohen et al, 1983).
- hydrolysis: the rate of degradation of a pesticide in water when no other process is taking place. This rate is particularly important because after a pesticide has leached below the soil zone of active biological activity, hydrolysis is essentially the only process available to decompose a pesticide. The time for hydrolysis to destroy half the amount of a pesticide present in solution is called the hydrolysis half-life; a value greater than about 6 months indicates chemicals with high potential to reach ground water.
- soil adsorption: the propensity of a chemical to bind to soil, defined as the ratio of concentration in soil to concentration in water at equilibrium. This ratio is denoted as Kd. A second measure, Koc, is a similar ratio based on the organic matter content of the soil, since organic matter is most active in binding chemicals present in soil. Pesticides with low values of Kd and Koc bind less strongly to soil and are therefore more likely to leach. Most of the pesticides found in ground water have Kd values less than about 5 (often less than 1); the corresponding Koc values are less than 300.
- soil degradation: a simplified measure of pesticide persistence in soil, usually measured as the time required for disappearance of one-half of the residue present. This time is called the half-life of the pesticide, and measures degradation by both chemical and biological processes in soil. Soil half-lives are measured by field experiments required for registration of pesticides; half-lives greater than about three weeks indicate soil persistence sufficient to allow high potential for leaching.

The downward movement of a pesticide is essentially driven by competition between the processes of degradation and leaching. A pesticide which degrades rapidly in surface soil (or which is efficiently taken up by plant roots) is unlikely to survive long enough to move downward under the influence of infiltrating water; and a pesticide which is tightly bound to soil will be unlikely to move downward no matter how long it remains in the soil. The combination of relative persistence in soil and lack of binding to the soil are the two dominant characteristics of pesticides which have the potential to leach to ground water.

3. Local Ground-Water Vulnerability

A number of factors determine the general vulnerability of local ground water to contamination by pesticides. Local climatic conditions are one of the most important determinants. Under this category, the amount of rainfall affects the amount of water available for transporting pesticides through soil to underlying ground water. Other key climatic conditions that affect pesticide degradation processes and vulnerability to contamination are soil and air temperatures.

The depth of the aquifer is another key determinant. If a pesticide has to travel a great distance to reach an aquifer, it has a greater chance to be diluted or degraded. A third key determinant of ground-water vulnerability is the type of soil present at a pesticide application site. The properties of the soil can vary greatly and depend on:

- clay content: the amount of clay minerals in the soil. The clay fraction provides cation exchange capacity to bind positively-charged chemicals (cations). Clay soils also have a high surface area which further contributes to adsorption capacity.
- organic matter content: also contributes to adsorption of pesticides to soil, particularly neutral species. In fact, pesticides which are applied to soils high in organic matter will often be applied at higher rates to compensate for this absorption.
- soil texture: refers to the percent of sand, silt, and clay in soil. Leaching is more rapid and deeper in course or light-textured soils than in fine or heavy-textured clay soils.
- soil structure: refers to the way soil grains are grouped together into larger aggregates -- as plates, prisms, blocks, uniform grains. Water and dissolved pesticides can percolate through cracks in soil structures. Often large cracks or channels resulting from soil biota are present, allowing rapid infiltration.

- porosity: a function of total pore space and pore size in soils. Porosity is determined by soil texture, aggregation, and particle shape. Water transport is more rapid in highly porous soils.
- soil moisture: interstitial water in the soil matrix ultimately dissolves and transports pesticides that are not adsorbed. Upward movement may also occur through capillary action or by evapotranspiration, in which water in the soil is lost to the air.

All of these factors determining general ground-water vulnerability can be assessed for any given site if data are available. Using these sets of factors, the Natural Water Well Association developed a system (DRASTIC) for assessing ground-water vulnerability. As an initial step in designing their national pesticide survey, EPA used the DRASTIC system to evaluate the average vulnerability of counties in the United States (See Figure I-6). The major drawback of this approach is that it does not account for the large variability of ground-water vulnerability within a given county, as Figure I-7 clearly demonstrates. Moreover, the presence of certain local features can make a certain area more susceptible to ground-water contamination than an average county-vulnerability score would indicate. These local features include the presence of sink holes, fissures, mine shafts, abandoned and uncapped wells, or poorly constructed and protected wells. Because of these problems, EPA has not used county average DRASTIC scores as a basis for pesticide regulation.

4. Agricultural Practices

The final group of factors affecting the potential for pesticides to contaminate ground waters are local agricultural practices. Obviously such practices will vary greatly across the country depending on the crops grown, local pest control needs and the preferences of the grower. Key factors that are part of the agricultural practices include:

- application rates: how much pesticide is applied has a direct effect on the amount of pesticide available for leaching.
- timing of application: when a pesticide is applied in relation to rainfall events, season of the year, or presence of crop cover can be a major factor.

Figure 1-6
Categories of Ground–Water Vulnerability; Coterminous United States

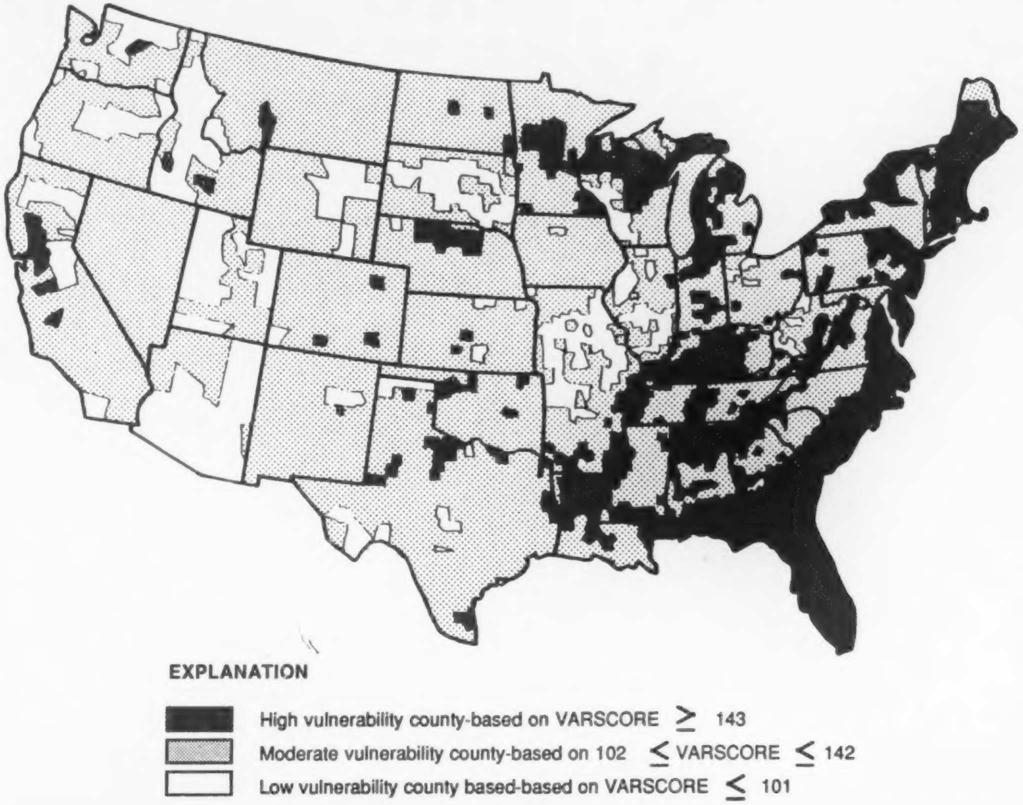
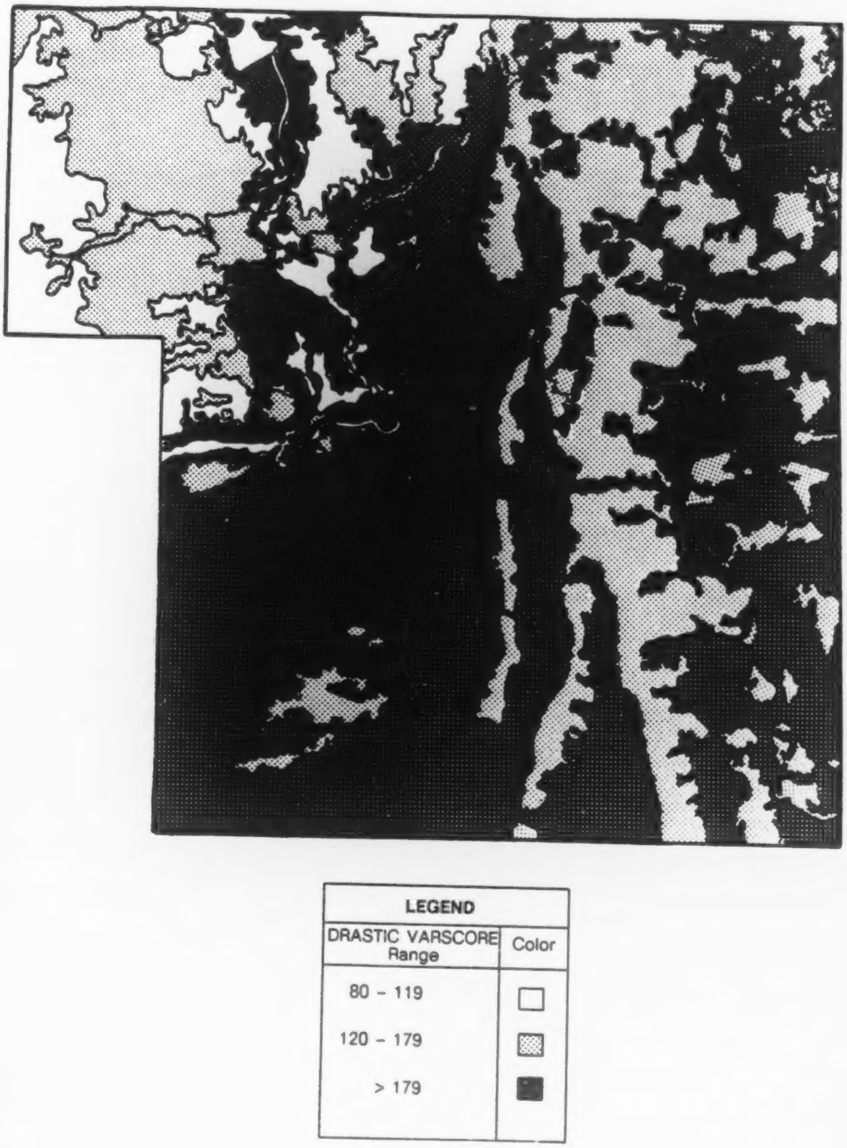

EXPLANATION
High vulnerability county-based on VARSCORE ≥ 143
Moderate vulnerability county-based on 102 ≤ VARSCORE ≤ 142
Low vulnerability county based-based on VARSCORE ≤ 101

Figure I-7

Map of Ground Water Pollution Potential Portage County, Wisconsin

Prepared by: National Water Well Association



LEGEND	
DRASTIC VARSCORE Range	Color
80 - 119	☐
120 - 179	▨
> 179	■

- method of application: pesticides can be applied as foliar sprays to standing crops or sprayed directly on bare soil, by dissolution in irrigation water, or by direct injection beneath the soil surface. Direct injection or soil incorporation of surface-applied pesticides pose the highest potential for ground-water contamination.

- cultivation practices: conservation tillage practices used to decrease soil erosion can increase water infiltration and concomitant leaching of soluble pesticides. These practices also often require increased use of herbicides.

- spillage and disposal: as discussed earlier, spills can result in high concentrations of pesticides in soil which can overwhelm decomposition and adsorption capabilities. Spillage can be a common problem where pesticide mixing and loading activities take place. Handling of empty containers and rinsate from cleaning spray equipment may also result in high localized concentrations of pesticides in soil.

- irrigation: soils under irrigation are highly permeable, and the amount of irrigation water commonly reaching subsurface soil is estimated to be 20 - 40% of the applied water. Irrigation practices, thus, have the potential to dissolve and increase the potential for soluble pesticides to leach ground water.

- chemigation: in this practice, pesticides are applied to the field by addition to irrigated waters. When the water comes from a well, decreases in water pressure can result in back-siphoning of the chemicals down the well if check valves preventing reverse flow are not installed.

For any specific location where pesticides are used, factors in the above four areas determine the potential for ground-water contamination. Not only is the combination of factors very complex, but they are also very specific to each location and vary greatly across all agricultural regions. Technical expertise is needed to evaluate these factors and their combinations, as well as knowledge of the specific local conditions and circumstances.

CHAPTER 4

STATUTORY AUTHORITIES AND INSTITUTIONAL FRAMEWORK

A complex set of Federal, State, and local laws authorize a wide variety of activities and programs that can be used to protect ground water from pesticide contamination. Many of these laws were written before pesticide contamination of ground water became a concern and subsequently have been broadly interpreted and expanded to cover this issue. Moreover, these laws sometimes provide conflicting direction regarding how the pesticides in ground-water concern should be managed.

1. Federal Level

At the Federal level, the primary agencies which have jurisdiction over pesticides in ground water are the U.S. Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), and the U.S. Department of Interior (DOI). The U.S. Geological Survey within DOI has the principal role for gathering hydrogeologic information on, and assessing the quality of, the nation's aquifers. Through a number of Federal-State cooperative programs, USGS and cooperative States compile information for planning, developing and managing the nation's water resources.

A second key player at the Federal level is the USDA. Through its Extension Service, Soil Conservation Service, Agricultural Stabilization and Conservation Service, and Agricultural Research Service, the USDA provides technical assistance to individual landowners and a range of incentives that can affect the way landowners choose to manage their land and water resources. Ultimately, landowners make choices regarding pesticide use and agricultural practices at their specific sites. Agencies, such as those found in USDA, which advise landowners play a significant role in ensuring that landowners make environmentally sound decisions.

The third critical player at the Federal level is EPA. This agency has the lead responsibility for regulating pesticide use in the United States and for protecting the quality of the nation's ground water. Within EPA, several environmental statutes and programs address one or more discrete sources of ground-water contamination (Figure I-8).

- The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) authorizes the Agency to regulate the marketing and use of pesticides in the United States. Before allowing a pesticide on the market, the Office of Pesticide Programs weighs the risks of a pesticide against its benefits. Manufacturers must submit extensive data to EPA, including environmental fate data which will indicate the leaching potential of a pesticide.

- The Safe Drinking Water Act (SWDA) is designed to ensure that public water systems provide water meeting minimum standards for protection of public health. As required by the Act, EPA establishes drinking water standards (Maximum Contaminant Levels) and water supply monitoring requirements for public water supplies to meet.

  Under recent amendments to the Act, the Agency has been authorized to provide resources to States to establish "Wellhead Protection Areas" (WHPA) for public drinking water wells. Other recent amendments restrict underground injection of hazardous waste and establish a sole source aquifer demonstration program.

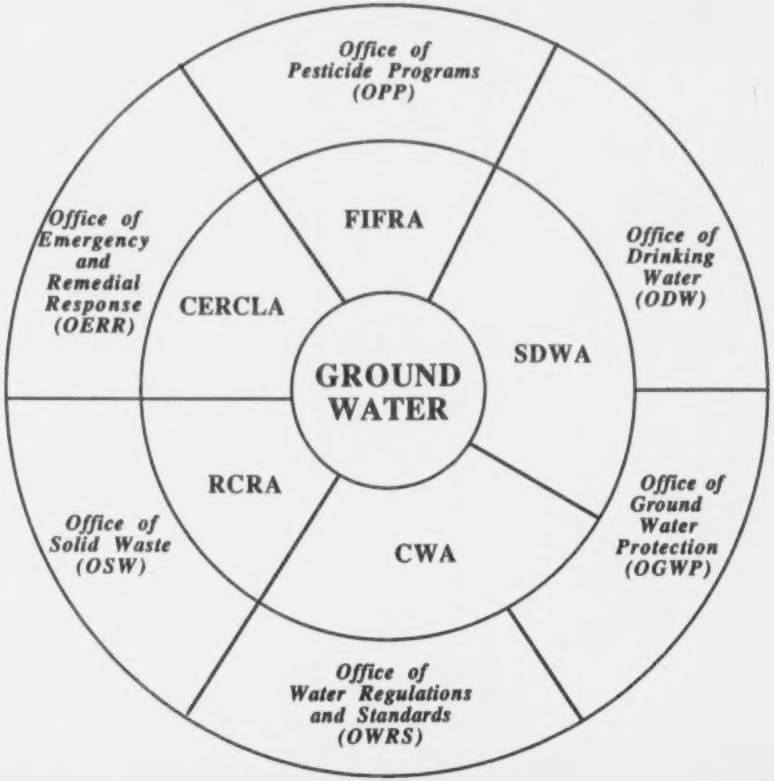
- Clean Water Act (CWA) The basic mission of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. EPA provides grants to States for development and implementation of State ground-water protection strategies. Under the CWA's nonpoint source authorities, EPA also provides financial assistance to States for nonpoint source monitoring/assessments, planning, program development, and demonstration projects.

- The Resource Conservation and Recovery Act (RCRA) regulates disposal of waste, including pesticides, which may create a hazard. Pesticide-containing wastes that are considered hazardous wastes under RCRA are subject to extensive regulatory requirements governing storage, transportation, treatment, and disposal.

- The Comprehensive Environmental Response, Compensation and Recovery Act (CERCLA) establishes a trust fund (Superfund) to finance government responses to releases or threats of releases of hazardous substances. However, if ground-water contamination results from normal application of pesticides, the law does not allow the Agency to recover costs from pesticide applicators or private users.

Figure I-8

EPA Offices Working to Protect Ground Water


Office of Pesticide Programs (OPP)
Office of Emergency and Remedial Response (OERR)
FIFRA
Office of Drinking Water (ODW)
CERCLA
SDWA
GROUND WATER
RCRA
Office of Ground Water Protection (OGWP)
Office of Solid Waste (OSW)
CWA
Office of Water Regulations and Standards (OWRS)

2. State Level

States have traditionally been responsible for implementing and enforcing Federal policies and standards. With the assistance of CWA grants, practically all States are now developing and implementing ground-water protection strategies addressing various sources of contamination, including pesticides. While many States have at least some activities addressing pesticide contamination, only a few have begun efforts that could be defined as prevention programs. Several States have established or are developing regulatory programs to require safety measures on chemigation systems and requirements for pesticide mixing, loading, and storage areas.

A few States are preparing for or have passed legislation aimed at protecting ground water from contamination. In addition, many States have initiated ground-water monitoring programs and have identified areas where pesticide contamination of ground water is a problem.

State efforts to address the pesticides in ground water concern have some of the same coordination problems that the Federal government has. Often, the agency responsible for pesticides control is housed in the State agricultural department, while primary responsibility for water quality and waste disposal programs is located in a State environmental protection agency. Responsibility for ensuring safe drinking water often rests in still another agency, such as a public health department. This fragmentation of responsibilities among various agencies makes it difficult to establish an effective Federal-State relationship.

3. Local Level

The United States has more than 91,000 units of local government which by and large operate under State control. The local governments are the first point of contact for controlling contamination of ground water. Through their land use and zoning powers, local governments can also closely influence ground-water use and quality.

In summary, protection of ground water from pesticide contamination will require a coordinated approach among a number of agencies at each level of government. Development of a national EPA strategy is one of the first steps needed in moving toward an integrated and successful management approach.

CHAPTER 5
CONCLUSION

The significant findings of this problem assessment are as follows:

1. Ground water is a valuable national resource; however, its value and use vary greatly across the country.

2. Ground water is vulnerable to contamination by normal use of pesticides as well as from leaks, spills and improper disposal.

3. Although the exact extent of the problem of pesticides in ground water is not known, enough information has been reported to indicate that ground-water contamination has occurred in a number of cases across the country.

4. While ground-water contamination by pesticides usually occurs at very low levels, significant levels have been found in some areas and have resulted in numerous well closings. Health and environmental risks associated with pesticides in ground water are a function of toxicity and exposure. The true magnitude of the problem is unclear at this time and may not be known for several years.

5. Once widespread contamination of ground water by pesticides has occurred, it will often be infeasible to clean up. Provisions of alternative water supplies or adequate treatment may also be impractical if contamination is widespread. For these reasons, prevention of unacceptable contamination must be the focus of protection efforts.

6. The potential for ground-water contamination by pesticides is determined by a complex set of factors which vary considerably from area to area. Understanding these factors is essential for designing an effective prevention strategy.

7. The highly variable characteristics of the ground-water resource and the site-specific nature of the ground-water problem demand a more localized approach for managing protection efforts.

8. The number and complexity of Federal and State programs and statutory authorities which may be used to address the pesticides in ground water concern are substantial. Protection of ground water from pesticide contamination will require a coordinated approach among Federal agencies and with the States.

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PART II
PROPOSED PESTICIDE STRATEGY

The purpose of this second part of the document is to present EPA's proposed strategy for addressing the pesticides in ground water concern. The presentation of the proposed strategy is divided into three chapters (Figure II-1):

- Environmental Goal
- Prevention Policy and Program
- Response Policy and Program

In the first chapter, the Agency defines its environmental goal in terms of what waters to protect and the criteria for determining protection. The resolution of these issues is a prerequisite for establishing policies for both prevention and response efforts.

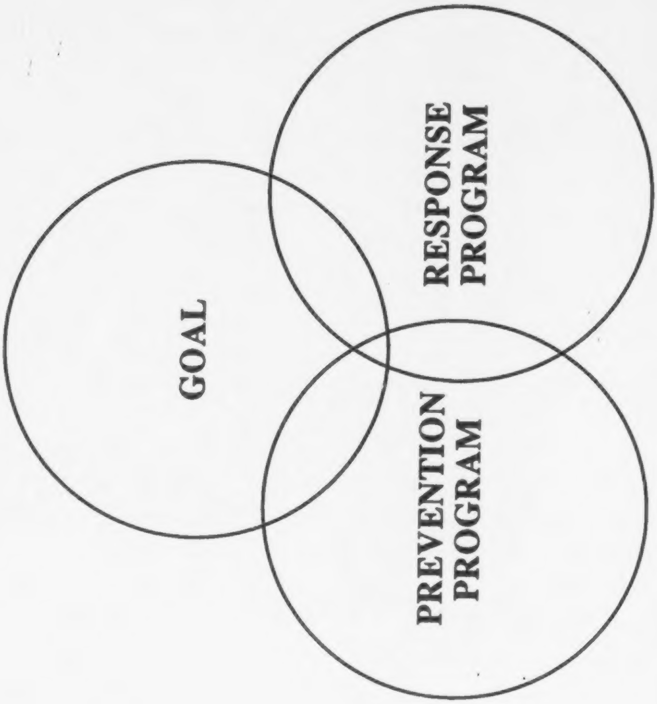
The second chapter presents the Agency's strategy for preventing contamination and focuses on the key issues of how to address local variability and the appropriate Federal/State roles and responsibilities in managing the problem. In defining its prevention policy and program, the Agency has examined options available, not only under its basic pesticide law, but also under other environmental authorities and the authorities of other Federal agencies as well as State capabilities.

The final chapter of the pesticide strategy establishes the overall framework for responding to ground-water contamination that has already occurred. Here again the critical question is the appropriate Federal and State roles and responsibilities.

For each of these chapters, the document will first highlight the options and the factors which the Agency considered in formulating its strategic approach. The second section of each chapter will present EPA's proposed approach and specific positions on a number of key issues.

Figure II-1

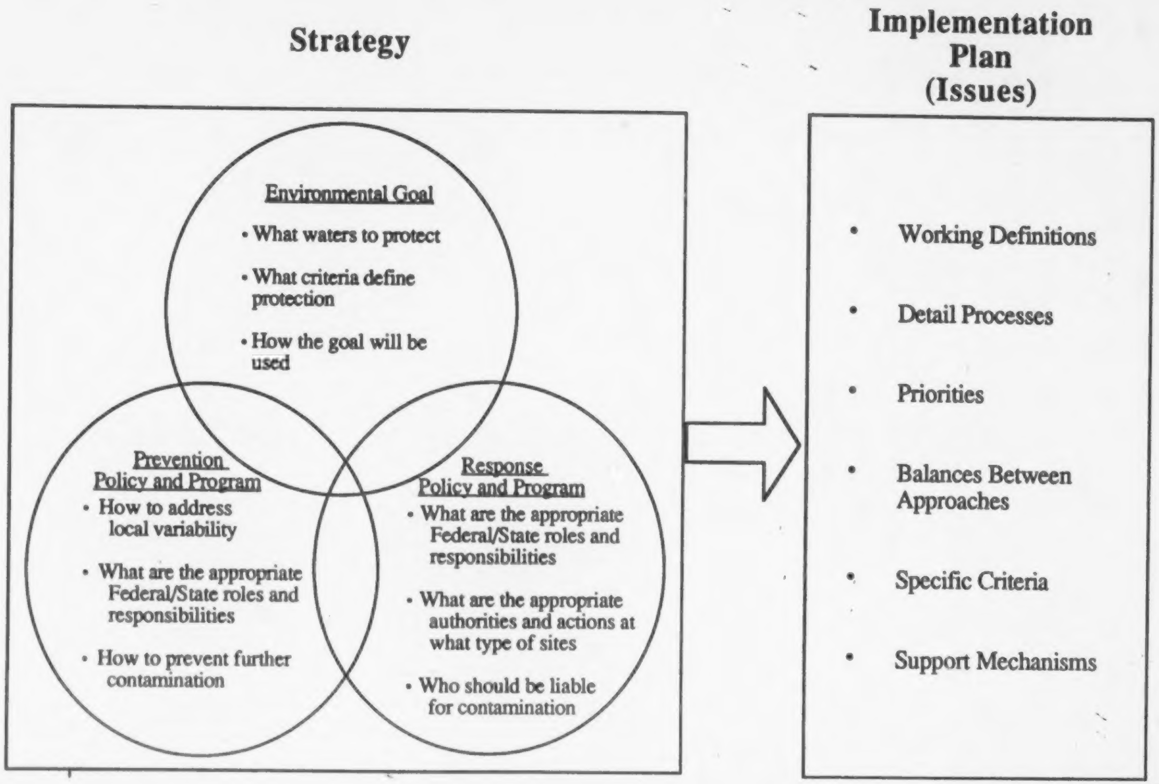
Pesticide Strategy


GOAL
RESPONSE PROGRAM
PREVENTION PROGRAM

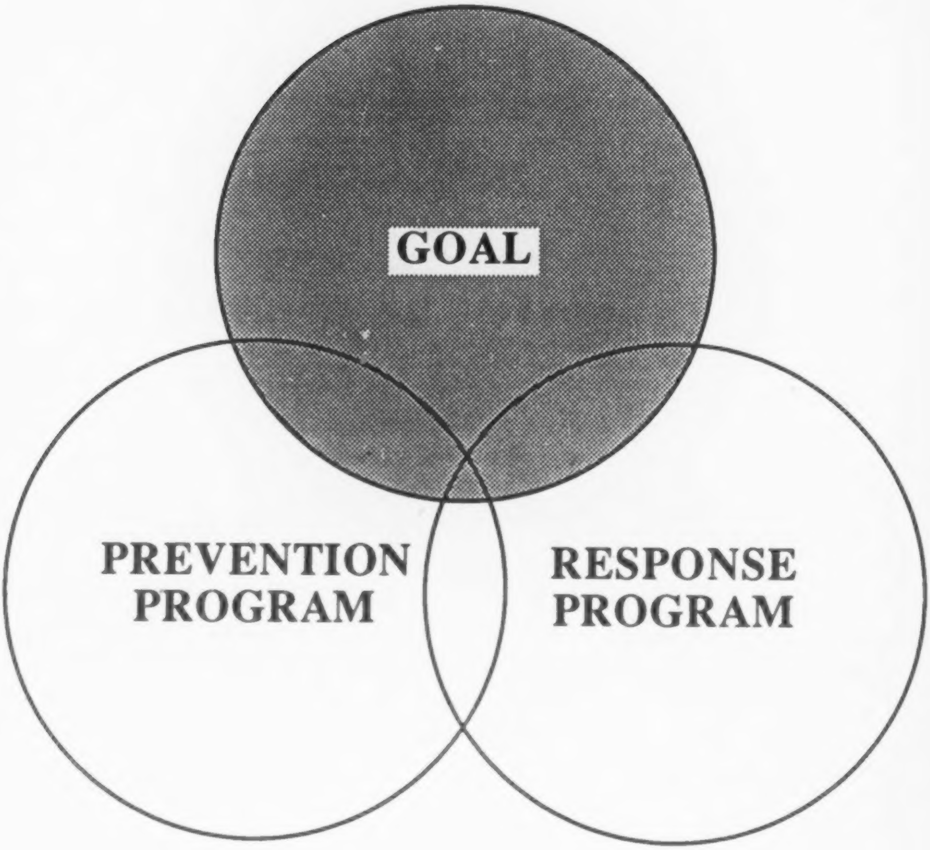
The policies presented in these three chapters form EPA's proposed strategy for dealing with pesticides in ground water. It is important to note that a number of key implementation issues are associated with this strategic approach. These issues are summarized in the final part of this document. The next major step in the planning process (Figure II-2) is to seek extensive input on these particular issues from State agencies, other Federal agencies, and other parties who will have key roles in the successful implementation of this strategy. After receiving public input on the proposed strategy and implementation issues, EPA will develop a detailed implementation plan -- the final step in the process.

Figure II-2

Pesticides in Ground Water Strategy


Strategy
Implementation Plan (Issues)
Environmental Goal
• What waters to protect
• What criteria define protection
• How the goal will be used
Prevention Policy and Program
• How to address local variability
• What are the appropriate Federal/State roles and responsibilities
• How to prevent further contamination
Response Policy and Program
• What are the appropriate Federal/State roles and responsibilities
• What are the appropriate authorities and actions at what type of sites
• Who should be liable for contamination
• Working Definitions
• Detail Processes
• Priorities
• Balances Between Approaches
• Specific Criteria
• Support Mechanisms

Pesticide Strategy



GOAL

PREVENTION PROGRAM

RESPONSE PROGRAM

PROPOSED STRATEGY

CHAPTER 1

ENVIRONMENTAL GOAL

EPA's proposed environmental goal will be to manage the use of pesticides in order to protect the ground-water resource. The Agency will give specific attention to preventing unacceptable contamination of current and potential drinking water supplies. MCLs or other EPA-designated criteria will be used as reference points for helping to define unacceptable contamination. This environmental goal will be used as a benchmark to:

- Identify and evaluate if, and where, the problem exists;
- Establish priorities to focus both prevention and response efforts;
- Select the most appropriate control measures; and
- Assess progress in preventing the problem or responding to existing threats.

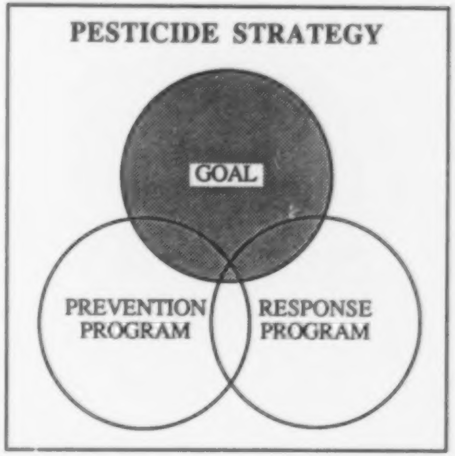
Below is a discussion of the options and factors which the Agency considered in developing its goal for the pesticides in ground water strategy. Following this section is a presentation of the Agency's proposed position on the key issues underlying the environmental goal.

SECTION 1: FACTORS AND OPTIONS CONSIDERED

The two key questions which the Agency has addressed in defining its environmental goal for pesticides in ground water are: (1) what waters to protect and (2) what criteria determine protection (Figure II-3). The Agency has addressed these questions within the context of its regulatory statutes and other Agency policies, including its basic policies for pesticide registration.

In 1984, EPA issued the EPA Ground-Water Protection Strategy (GWPS) after many years of internal debate and external review and comment. The Strategy sets out goals and objectives for the Agency's ground-water protection efforts. In the GWPS, EPA established the policy of protecting the

Figure II-3


PESTICIDE STRATEGY
GOAL
PREVENTION PROGRAM
RESPONSE PROGRAM

Goal Definition Issues:

- What Waters to Protect
- What Criteria Determine Protection

ground-water resource to ensure its quality for the highest present or potential beneficial use. The highest beneficial use is defined as drinking water.

The GWPS also developed a general policy for classifying ground waters based on their use, value, and vulnerability. Dividing ground water into three classes, this policy provides an extra degree of protection to ground water that is highly vulnerable to contamination and is of great value because of its importance as a source of drinking water or its contribution to a unique ecological habitat (Class I). The majority of the nation's ground water is in Class II, a current or potential source of drinking water, and it is for this ground water that certain EPA ground-water protection requirements are designed. Class III ground water is not a potential source of drinking water because of levels of contamination from naturally occurring conditions or the effects of broad-scale human activity.

The strategy proposed in this document affirms the intended extension of EPA's basic ground-water policies to the Agency's efforts to protect ground water from pesticide contamination. A number of policy issues and options, already addressed under the GWPS, are presented here with options primarily for those who may not be familiar with the Agency's basic ground-water policies.

In developing the strategic approach for pesticides in ground water, EPA considered several aspects of this overall Agency policy for ground-water protection to determine the extent to which they were appropriate for the pesticides effort. Alternative approaches, such as approaches that would focus only on ground water currently supplying a drinking water well or that would solely rely on treatment at the tap as the means for protecting public health, were rejected as inadequate for protecting the ground-water resource for present and future generations. The Agency concluded that while the unique needs of agriculture must be accommodated in the strategic approach for pesticides, the basic policy of protecting the ground-water resource itself and focusing efforts on current and potential sources of drinking water would be the appropriate framework. The differential approach in the EPA Ground-Water Protection Strategy allows management strategies to be tailored to ground waters of varying use, value, and vulnerability, but aims at adequate protection for all ground water that is a current or potential drinking water supply.

The following discussion outlines the factors and options which EPA considered in determining its environmental goal for addressing the pesticides in ground water concern.

1. What Waters to Protect

Ground waters vary greatly in how they are used and in their value to society. For example, in some areas, ground water may provide an irreplaceable source of drinking water to a large population, while in other areas, ground water may not be usable as a drinking water source because of its high salinity or its low yield. Other ground water, that may or may not be a drinking water source, could be valued for its importance to an area's fragile ecosystems.

The first issue in determining what waters to protect is whether protection efforts should be focused on assuring the quality of the groundwater resource or the quality of water actually delivered to the tap for drinking (Figure II-4). The difference between these two options is that the latter choice could allow for the contamination of ground water in areas where there is adequate treatment capability for reducing contamination to acceptable levels before it is provided for drinking.

A second key decision for the Agency is to determine whether to spread its protection efforts widely to protect all ground waters or to narrow its protection focus on some selected waters that provide more valuable use. If the Agency focuses its efforts on assuring that safe drinking water is provided, it would have to decide whether to protect private wells to the same extent as public water systems. If the Agency chooses to protect water in the ground, then the Agency has a number of options, based upon the different degrees of use and value of ground water (see Figure II-5), including:

Figure II-4

What Waters to Protect

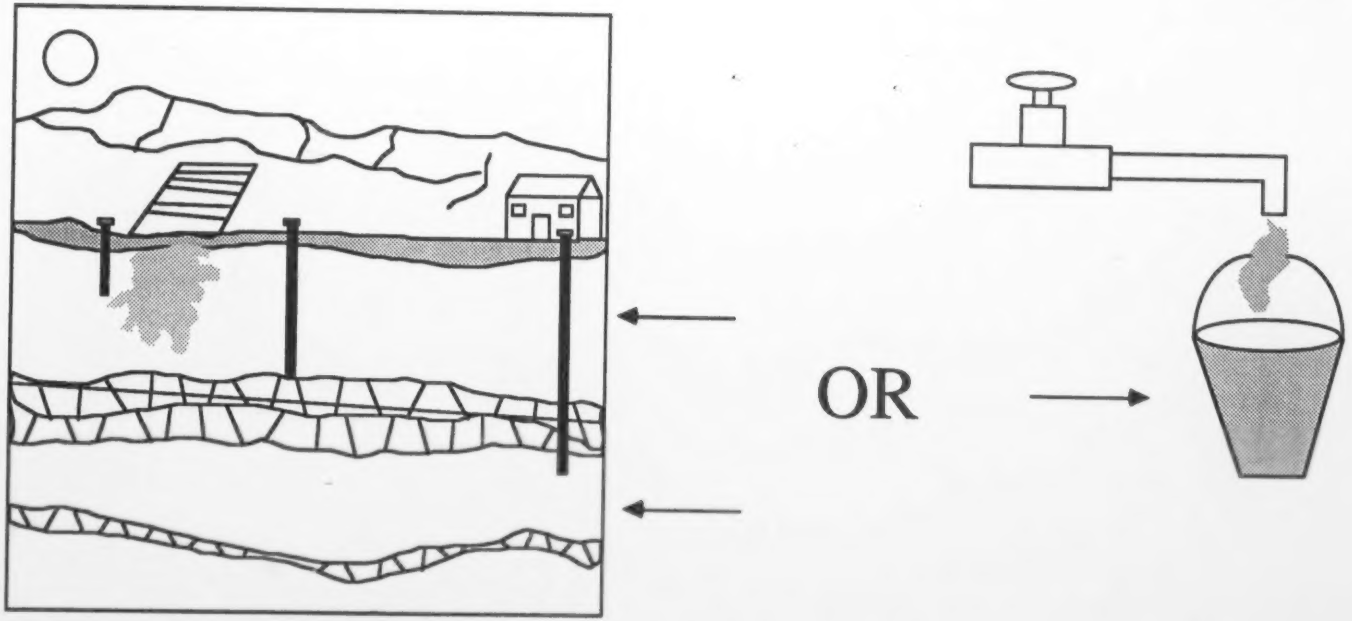
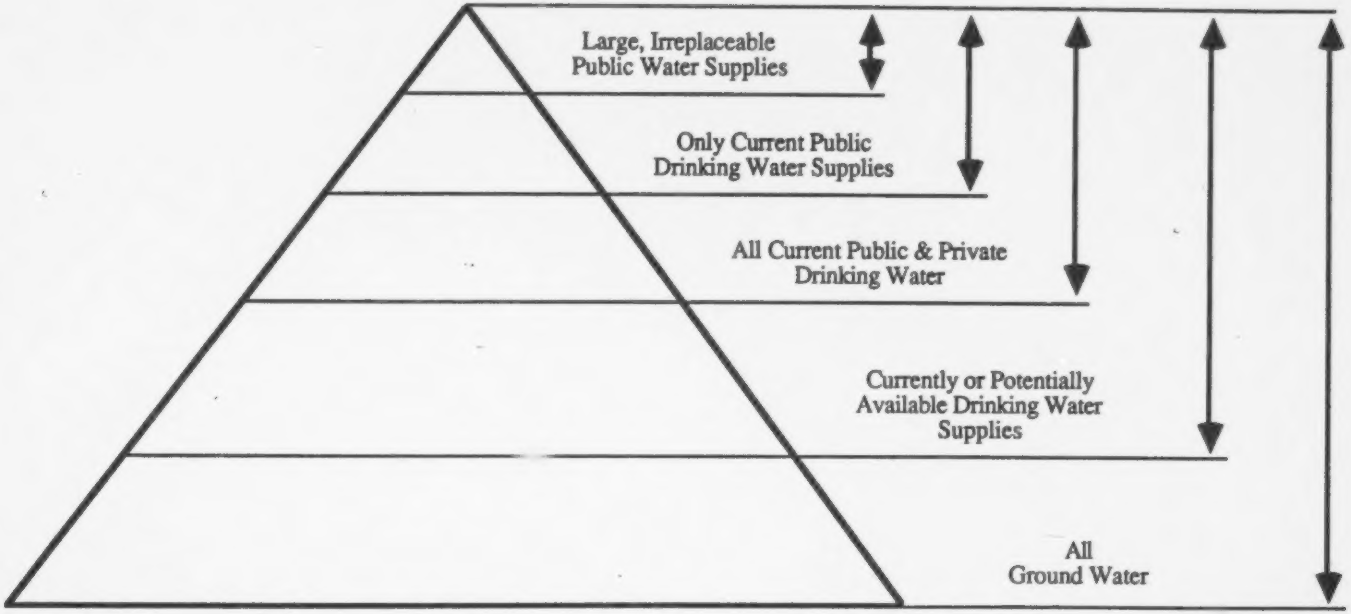

In-ground Supplies
OR
Tap Water

Figure II-5

What Waters to Target for Protection


Large, Irreplaceable Public Water Supplies
Only Current Public Drinking Water Supplies
All Current Public & Private Drinking Water
Currently or Potentially Available Drinking Water Supplies
All Ground Water

- **Protection for All Ground Water** - One option is to protect all ground water as it exists in the saturated zone regardless of its current or potential use as a drinking water source. (As seen in Figure II-6, the saturated zone lies below the unsaturated zone, which is the first zone of water and soil below the surface layer).

- **Protection for All Ground-Water Resources That Are Current or Potential Drinking Water Sources or of Ecological Importance** - This option would also protect the ground water in the saturated zone, but would limit protection to those ground-water resources that are currently or potentially available for drinking water. A key consideration in implementing this option would be defining potential drinking water.

- **Protection for Only that Ground Water Currently Used as a Drinking Water Source** - This option would limit protection to those ground-water resources that currently supply drinking water. A key implementation issue would be defining what ground water actually supplies a drinking water well.

- **Protection for Only that Ground Water Supplying Public Drinking Water Systems** - This option is similar to the previous one except that protection is limited to those ground waters that supply public water systems. Again, a key implementation issue would be deciding what ground water actually supplies these drinking water wells.

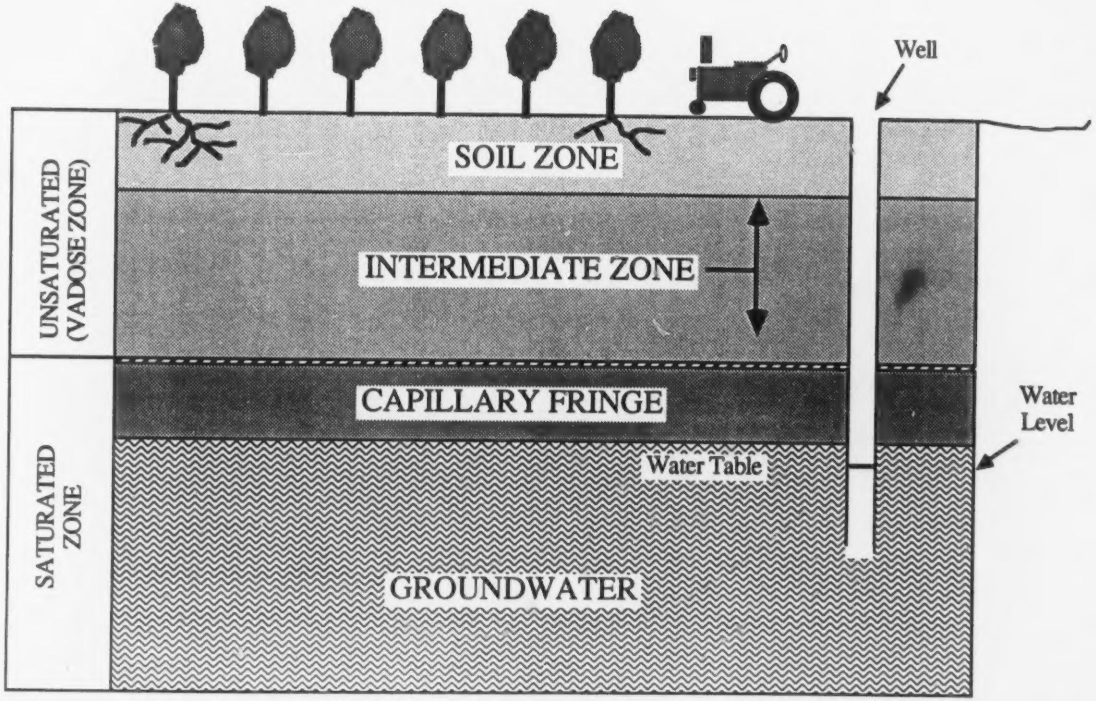
- **Differential Ground-Water Protection** - With this option, all ground waters would be considered for protection, but priorities and stringency of prevention and response efforts would be based on the relative use and value of the ground water. For example, basic protection efforts could be provided for ground waters that are a current source of drinking water. Higher degrees of protection could be provided to ground waters that serve large populations. On a case-by-case basis, some ground waters that are not a drinking water source could be afforded less protection where conditions warranted such actions.

With regard to what waters to protect, EPA's legislative priorities provide somewhat different direction. The major relevant EPA statutes which address this question include:

- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) - The basic pesticide law, FIFRA does not specifically identify ground water as an environmental medium requiring protection. However, EPA recognizes that the public may be exposed to pesticides in drinking water as a result of contaminated ground water, and thus, the ground-water medium is included in EPA's interpretation of FIFRA's general requirement for protection of the environment. In addition, several recently proposed bills to amend FIFRA would mandate a differential protection approach requiring special protective measures for ground waters that are a current or potential source of drinking water.

Figure II-6

Zones of Subsurface Water


Well
SOIL ZONE
INTERMEDIATE ZONE
CAPILLARY FRINGE
Water Table
GROUNDWATER
Water Level
UNSATURATED (VADOSE ZONE)
SATURATED ZONE

- **Safe Drinking Water Act (SDWA)** - Federally-enforceable drinking water standards under the SDWA are limited to the drinking water that is provided by public water systems, i.e., those systems having at least 15 service connections or serving at least 25 persons daily. If the question of what waters to protect is limited to those waters covered by these SDWA drinking water standards, then individual private wells, which are often found in rural areas and are most at risk from pesticide contamination, would be excluded. (Note - some States do take action for private wells based on SDWA drinking water standards.)

  Another important factor to consider is that these SDWA drinking water standards, which apply to public water systems, do not apply to the ambient or raw water used by these systems unless it is provided directly to the public. The public system can treat or blend its water, however, to meet SDWA drinking water standards before delivering it to the user.

  The 1986 amendments to the SDWA established the Wellhead Protection Program which, unlike previous SDWA measures, is designed to protect ambient ground waters, but the focus remains on public water systems and has no Federally-enforceable quality standards.

- **Clean Water Act (CWA)** - As amended by the Water Quality Act of 1987 (WQA), the CWA does not differentiate ground water in terms of its protection goal of restoring and maintaining the integrity of the Nation's waters.

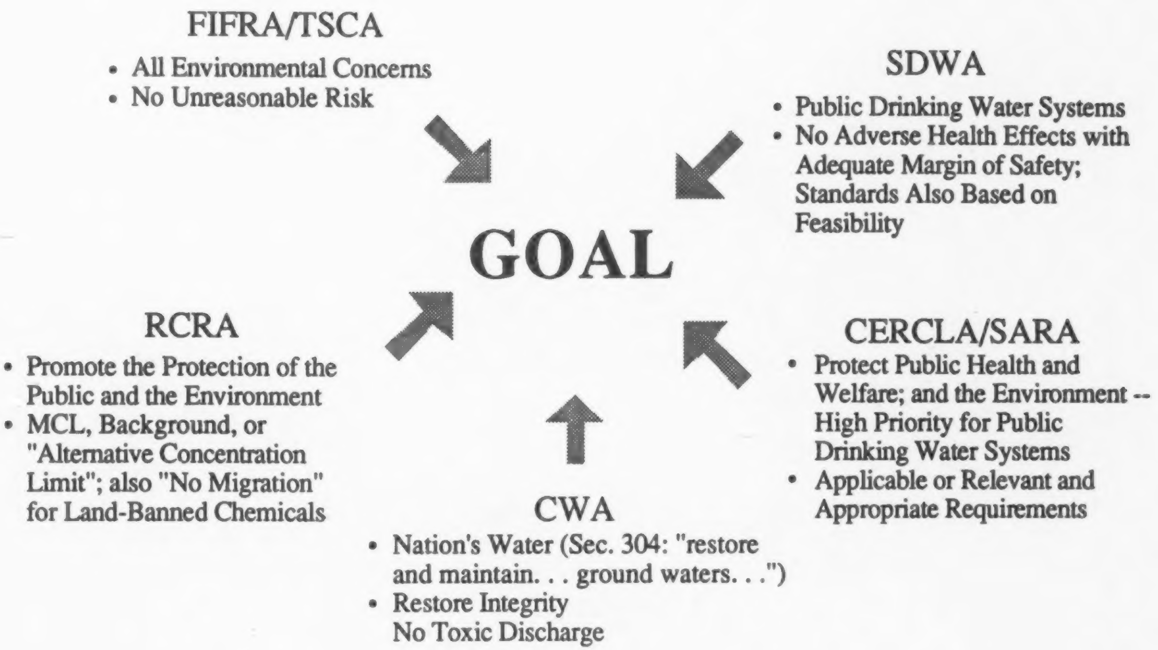
- **Resource Conservation and Recovery Act (RCRA)** - As amended by the Hazardous and Solid Waste Amendment of 1984 (HWSA), RCRA identifies ground water as a specific medium for protection and requires ground-water monitoring at hazardous waste facilities.

- **Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Superfund")** - As amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), CERCLA establishes criteria for determining response priorities among releases or threatened releases of hazardous substances. The potential for a release to contaminate a drinking water supply is a major CERCLA criterion. Under CERCLA, a drinking water supply is defined as being "any raw or finished water source that is or may be used by a public water system (as defined by SDWA) or as drinking water by one or more individuals," which would include private wells.

In summary, EPA's various legislative statutes provide a range of guidance on what ground waters to protect (Figure II-7). In some of EPA's existing statutes, ground water is not specifically mentioned; in others, EPA's enforceable authorities are limited to ensuring that the quality of drinking water supplied by public water systems is adequate.

Figure II-7

Goal:
Varied Legislative Direction



GOAL

FIFRA/TSCA

- All Environmental Concerns
- No Unreasonable Risk

SDWA

- Public Drinking Water Systems
- No Adverse Health Effects with Adequate Margin of Safety; Standards Also Based on Feasibility

RCRA

- Promote the Protection of the Public and the Environment
- MCL, Background, or "Alternative Concentration Limit"; also "No Migration" for Land-Banned Chemicals

CWA

- Nation's Water (Sec. 304: "restore and maintain. . . ground waters. . .")
- Restore Integrity
  No Toxic Discharge

CERCLA/SARA

- Protect Public Health and Welfare; and the Environment -- High Priority for Public Drinking Water Systems
- Applicable or Relevant and Appropriate Requirements

In addition to these legislative considerations, the Agency also considered its existing policies in addressing the question of what waters to protect. In this regard, the Agency's basic ground-water policy states that the ground-water resource will be protected to ensure quality for the highest present or potential beneficial use. The highest beneficial use is defined as drinking water. The Agency's basic policy is also based on differential protection in regard to the use, value, and vulnerability of ground waters.

2. What Criteria Determine Protection

The second key part of the Agency's goal is identifying the criteria to be used for determining protection. Again, the Agency's legislative authorities provide varying guidance for addressing this issue (Figure II-7).

- **Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)** - This basic pesticide law requires the Agency to weigh the health and environmental risks of the use of each pesticide against the benefits of such use. Those pesticide uses which are found not to present an unreasonable risk may be registered.
- **Safe Drinking Water Act (SDWA)** - In contrast to FIFRA, the SDWA does not require considerations of the benefits of any regulated chemicals, including pesticides. Rather, the SDWA establishes a goal of protecting public health from exposures to contaminated public water supplies. SDWA standards are set as close as possible to those goals, but must take into account the cost and availability of feasible treatment technology to reduce contamination of water delivered to the consumer.
- **Clean Water Act (CWA)** - The stated goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. EPA has established human health protection criteria for pesticides in edible fish tissue based on levels that provide negligible or no significant risks.
- **Resource Conservation and Recovery Act (RCRA)** - Under RCRA, the contamination of ground water by hazardous waste facilities cannot exceed standards based on background environmental levels, SDWA standards, or levels that would pose a substantial present or potential hazard to human health or the environment. Of particular note, RCRA does provide EPA more flexibility in establishing protection criteria for releases from nonhazardous waste facilities, such as municipal landfills.

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) - CERCLA or "Superfund" must be considered when responding to existing contamination. As amended by SARA in 1986, CERCLA now requires that clean-up levels (i.e., protection criteria) be defined in terms of applicable or relevant and appropriate regulatory requirements of other environmental statutes, such as the SDWA and CWA.

To date, the Agency has discussed the question of what criteria to use for ground-water protection mainly in relationship to the regulation of waste sites. This discussion has focused on both the differences within a statute (i.e., RCRA requirements for hazardous waste facilities versus nonhazardous waste facilities), as well as between statutes (i.e., RCRA versus CERCLA). When pesticides are considered in this discussion, the extent of the differences in legislative direction becomes even more pronounced.

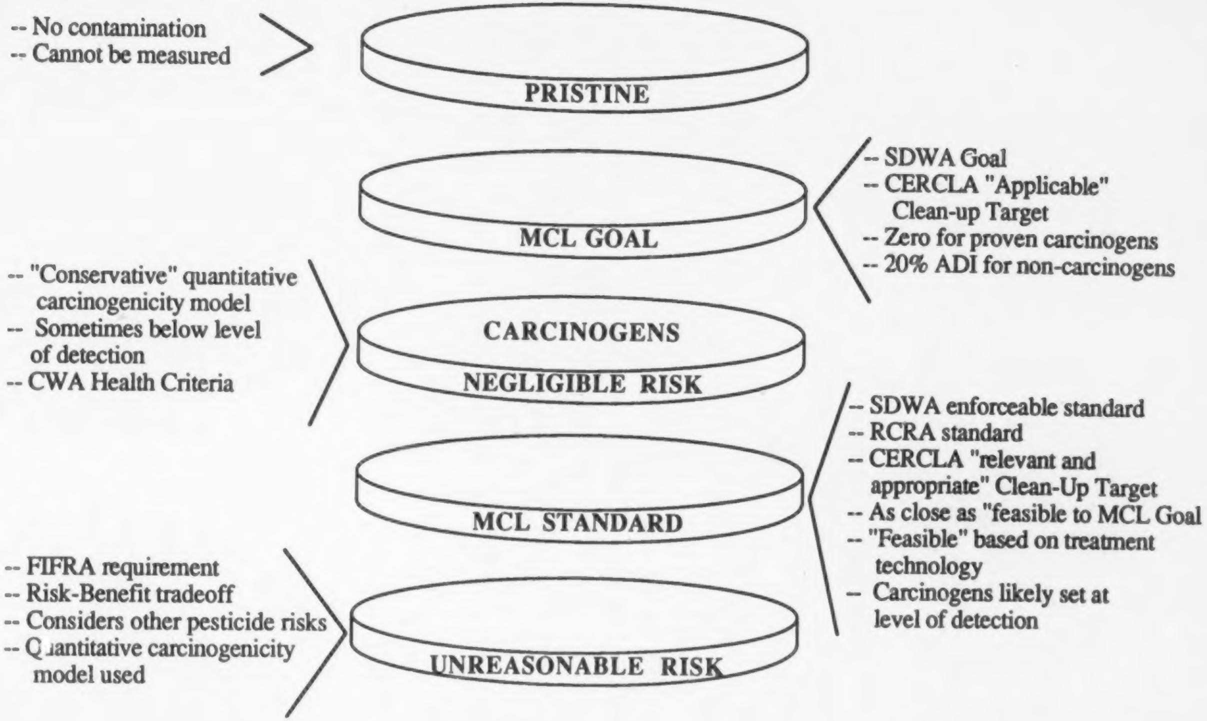
As described above, FIFRA requires the Agency to consider the benefits of a pesticide as well as its risks. Those risks considered reasonable under FIFRA's mandate may not be consistent with the regulatory policies established under other environmental statutes. The potential for this discrepancy is perhaps greater for ground water than for other pesticide concerns because of the number of relevant statutes.

The options which EPA considered for the criteria for defining protection are shown in Figure II-8 and include:

a) **PRISTINE** - Protection criteria based on pristine conditions would require prevention efforts that are designed to achieve zero contamination in waters chosen for protection. With this option, response efforts would have to restore protected ground waters to zero contamination levels. While an unspoiled environment is desirable, there are a number of practical barriers to achieving such a goal. First of all, zero is not scientifically measurable and therefore not attainable. Secondly, efforts to attain pristine ground water would be enormously expensive and would limit greatly the type of waters that could be targeted for such protection.

Figure II-8

Basic Protection Criteria Options



- -- No contamination
- -- Cannot be measured

PRISTINE

MCL GOAL

- -- SDWA Goal
- -- CERCLA "Applicable" Clean-up Target
- -- Zero for proven carcinogens
- -- 20% ADI for non-carcinogens

- -- "Conservative" quantitative carcinogenicity model
- -- Sometimes below level of detection
- -- CWA Health Criteria

CARCINOGENS NEGLIGIBLE RISK

MCL STANDARD

- -- SDWA enforceable standard
- -- RCRA standard
- -- CERCLA "relevant and appropriate" Clean-Up Target
- -- As close as "feasible to MCL Goal
- -- "Feasible" based on treatment technology
- -- Carcinogens likely set at level of detection

- -- FIFRA requirement
- -- Risk-Benefit tradeoff
- -- Considers other pesticide risks
- -- Quantitative carcinogenicity model used

UNREASONABLE RISK

b) **MAXIMUM CONTAMINANT LEVEL GOAL (MCLG)** - The SDWA requires the Agency to set a Maximum Contaminant Level Goal (MCLG) for any potential drinking water pollutant at a level that has no known or anticipated adverse effect. EPA's policy has been to set the MCLG at absolute zero for a chemical proven to be carcinogenic (cancer-causing) in humans, or a probable carcinogen in animal studies. For noncarcinogens, the MCLG is set at a level corresponding to a percentage of the Acceptable Daily Intake (ADI) or more recently, Reference Dose (RfD).1/

In developing the MCLG policy, EPA considered setting the MCLGs for carcinogens at the lowest levels that could be detected by modern analytical technology (the limits of detection). The Agency also considered setting MCLGs at levels that would pose insignificant or negligible risks (see below). The Agency's most compelling argument for choosing the more conservative option of absolute zero for probable carcinogens is that the MCLG was not intended to be used as a practical regulatory standard, but rather as a statement of the SDWA program's general long-term aim.

Where the concern is for a carcinogenic pesticide in ground water, the use of the MCLG as the protection criterion would have the same problems as the pristine option. In this case, a measurable goal could not be established because a zero level is not scientifically measurable. Furthermore, prevention and response efforts could constantly be in doubt as the ability to measure smaller and smaller levels of environmental contaminants progresses. Use of the MCLG as the criterion for protection could also skew public health and environmental priorities since this approach does not consider the relative potency of different carcinogens, nor does this

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1/ To simplify somewhat, the ADI is developed by first determining the concentration of a chemical that shows no observable effect level (NOEL) in animal tests. After factoring the size of humans and possible other biological differences, the NOEL is divided by a margin of safety factor, the magnitude of which is determined by the quality of the toxicology data and other factors. EPA uses a percent of the ADI for setting an MCLG because humans may be exposed to the chemical through other routes such as food.

approach consider that a noncarcinogen could pose a much greater risk than a weak carcinogen. Furthermore, as with the pristine option, the cost of protecting, monitoring, and restoring ground water based on a zero level may limit greatly the type of waters that could be targeted for such protection.

c) **NEGLIGIBLE RISK** - EPA has applied the concept of negligible risk to carcinogens. Substances shown primarily through controlled animal studies to have the capacity to cause cancer (malignant tumors) are considered to be carcinogens. In assessing the risks of these substances, EPA assumes that there is no level of exposure that has a zero chance or risk of an adverse effect. However, the risks are assumed to be proportional to the level of exposure. Therefore, at some exposure level the risk posed by a carcinogen can be considered to be insignificant or negligible.

EPA uses a number of "worst case" assumptions to estimate the risks to humans from environmental exposures to carcinogens based on extrapolations from animal studies. If a "worst case" or "upper bound" estimate of cancer risk is one in a million (1×10^{-6}) or less, the risk at that level of exposure is generally considered to be insignificant or negligible.

The use of negligible risk as the basis for a protection criterion provides a level that is considered very protective of human health. Such a goal could be measurable, but for some chemicals the concentration of a chemical at a negligible risk level may not be detectable. In this case, a decision would have to be made to accept the limits of detection as an acceptable level. Because of its stringency, a standard based on the concept of negligible risk may not be achievable as a clean-up standard for certain pesticide contamination incidents.

d) **MCL STANDARD** - Following the development of an MCLG, the SDWA requires EPA to establish a Maximum Contaminant Level (MCL) that is the enforceable standard used to guard the adequacy of the drinking water provided by public water systems. The SDWA requires EPA to set the MCL as close as possible to the MCLG, taking into account the cost and feasibility of measuring and reducing the contamination. MCLs are set in a range that is considered protective of human health.

MCLs as protection criteria have already been established for public water systems, and as such they can provide measurable goals. In some cases, though, MCL's may be difficult to achieve, particularly when they are used to protect private well water or the ground-water resource. Like the previous options, MCL's are not based on a consideration of the benefits of the contaminants to society.

e) **UNREASONABLE RISK** - As mentioned earlier, FIFRA is a risk-benefit statute and requires the weighing of the human health risks posed by a pesticide's use against its benefits. In some cases, concentrations posing a nonnegligible risk may be tolerated if the benefits of the pesticide's use are found to be uniquely critical.

The key question for the Agency is how to develop a goal for protecting ground water from pesticide contamination that is compatible with the requirements under each of its legislative mandates. From a prevention perspective, FIFRA requires the Agency to weigh the benefits of a pesticide's use against its risks. Obviously, EPA must attempt to prevent the creation of contamination problems that would require corrective actions, such as treatment by public water systems. From a response perspective, actions are based on criteria (e.g., SDWA goals and standards) that do not consider the benefits of pesticide use. The critical issue is whether the criteria used to define protection under other legislation can be used as the basis for unreasonable risk determinations under FIFRA.

SECTION 2: EPA'S PROPOSED POLICY POSITION

EPA's proposed environmental goal will be to protect the ground-water resource with the key focus on preventing unacceptable contamination of current and potential drinking water supplies. MCLs or other EPA-designated protection criteria will be used as reference points for helping to determine unacceptable levels of contamination. Specifically, the Agency will adopt the following policies for protecting ground water from pesticide contamination:

1. The Agency will use a differential protection approach to protect the ground-water resource. With this approach, the Agency will focus protection efforts on ground waters that are current or potential sources of drinking water or that are vital to fragile ecosystems (Figure II-9). Additional measures may be taken to ensure protection of certain "high priority ground waters."

Ground water provides nearly half of the drinking water used in this country. Regardless of whether that water is being provided through a community public water system or to a private individual, it is not usually monitored for the presence of pesticide residues, nor is it usually subject to any treatment technology capable of removing low, but possibly health-significant, levels of pesticides.

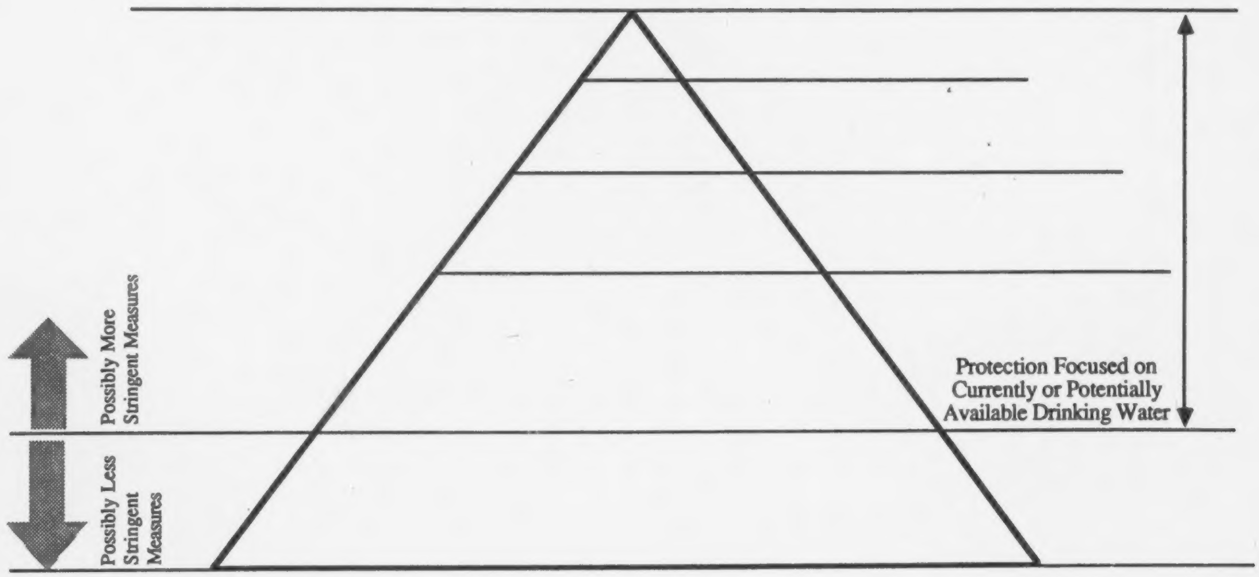
Under the SDWA, EPA is establishing standards which will require public drinking water systems to identify, and where necessary, to remove pesticide residues posing potential health concerns before supplying the water for use. However, it will take substantial time and investment for public systems to achieve this capability; these requirements also will not be applied to the approximately 12 million private wells that supply drinking water to millions of Americans. Thus, EPA must assume that contaminated ground waters which are used as a source of drinking water may result in direct human exposure. It is the Agency's position that protection of these ground waters is synonymous with public health protection. As such, EPA's protection efforts must target those ground-water resources that serve as drinking water sources.

Since the natural cleansing processes of ground waters can be extremely slow, contamination of this resource poses a potential hazard for future generations. Contaminated ground water could be used as a drinking water source before being tested for contamination. Where contamination is

Figure II-9

What Waters to Target for Protection

EPA Policy:
Differential Protection Based on Use and Value
of the Ground Water Resource


Protection Focused on
Currently or Potentially
Available Drinking Water
Possibly More
Stringent Measures
Possibly Less
Stringent
Measures

identified, efforts could be made to restore the ground water for use as a drinking water source, but this option could present insurmountable technological difficulties and exorbitant costs.

In practice, alternative water sources or point-of-use treatment, if technology is available, may be the only viable preventive measures for a community. Although local governments could regulate the placement and construction of wells, there is the possibility that these ordinances may eventually be ignored or overlooked before the ground water has been cleansed by natural processes. For these reasons, EPA may have to assume that contaminated ground water that is a potential drinking water source could eventually result in human exposure. EPA's protection goal therefore includes ground-water resources that are potential as well as current sources of drinking water.

The need to protect the ground-water resource is further underscored by the fact that ground waters provide approximately 30% of the annual base flow to surface water systems. In certain dry areas of the country or during periods of drought, ground-water flows to surface waters can have a more dominant role. As such, the continued existence of fragile ecosystems may depend on the quality of certain ground water. To meet its basic environmental protection mission, EPA must focus protection efforts on ground-water resources from an ecological perspective as well as from a public health concern.

As part of its differential protection approach, the Agency will take additional measures to protect "high priority ground water." These "high priority ground waters" may serve as irreplaceable sources of drinking water for sizable communities, or they may be vital to the continued survival of endangered species or critical ecosystems. For these situations, additional measures, beyond baseline protective efforts, may be required to provide further assurances that these, and perhaps other, "high priority ground waters" are not contaminated or that they have priority for corrective actions, if already contaminated.

2. EPA will use MCLs, as defined under the SDWA, as reference points for helping to determine unacceptable contamination of ground waters that are drinking water sources. When no MCL exists, EPA will use interim drinking water protection criteria as its reference points. These will be equivalent to an MCLG for noncarcinogenic pesticides and to a negligible risk level for carcinogenic pesticides (Figure II-10). The Agency will also use ecologically based protection criteria as reference points for helping to determine unacceptable contamination of ground waters.

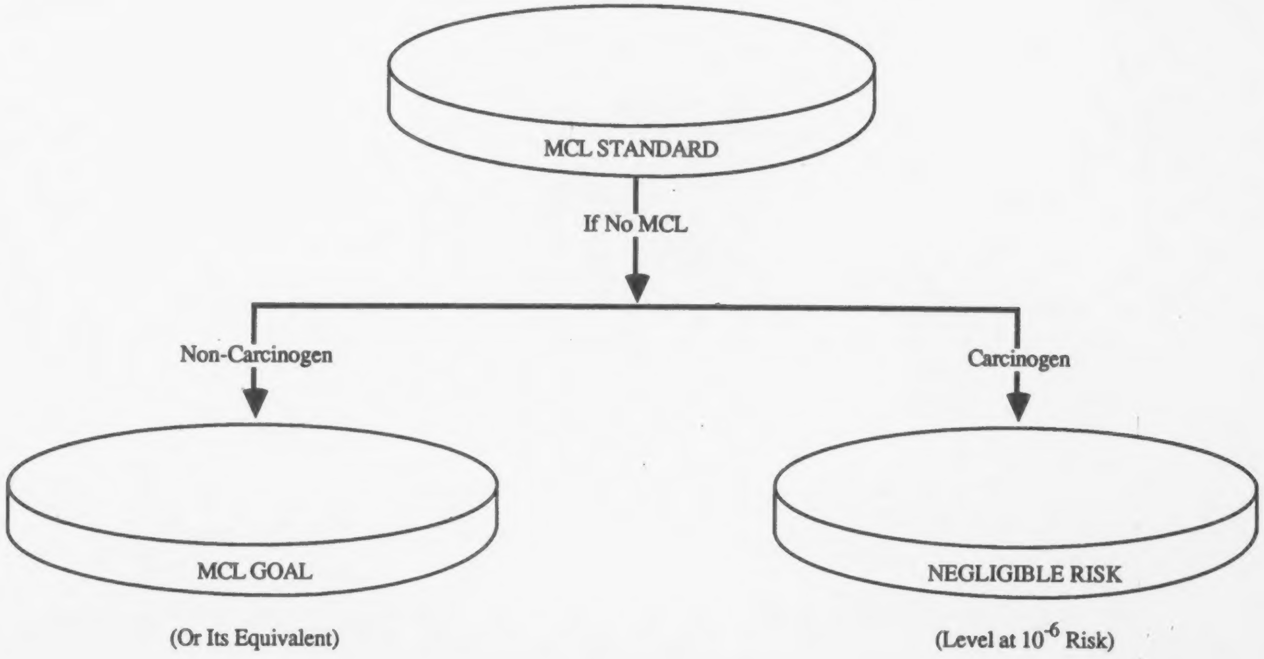
Under the 1986 SDWA Amendments, EPA is moving to establish new MCLs for potential drinking water contaminants, including a number of pesticides. In the interim, EPA will have available other drinking water protection criteria that will be based on standard risk assessment procedures. For noncarcinogens, EPA will establish these interim protection criteria based on a No Observable Effect Level (NOEL) with appropriate margins of safety of two or three orders of magnitude depending on the confidence in the toxicity data and other risk assessment factors (this approach is essentially the same one used for setting an MCLG for a noncarcinogen). For carcinogens, the interim protection criteria will be set at a level that corresponds to a negligible risk, i.e., the level of exposure that has an upper bound estimate of one in a million chance of causing cancer (see previous description). Establishment of interim protection criteria for pesticides in drinking water is jointly undertaken by EPA's Office of Drinking Water and Office of Pesticide Programs. EPA has recently developed interim levels for over 60 pesticides through the Agency's health advisory process.

Since an MCL or an interim protection criteria is developed for human health reasons, these levels could pose concern for fragile aquatic ecosystems. Of particular concern would be pesticide contamination that would result in risks to endangered species. Because the Agency's mandate is to protect the environment as well as public health, EPA also establishes ecologically based protection criteria. EPA's Office of Pesticide Programs

Figure II-10

What Criteria Determine Protection

EPA Policy:



MCL STANDARD

If No MCL

Non-Carcinogen

MCL GOAL

(Or Its Equivalent)

Carcinogen

NEGLIGIBLE RISK

(Level at 10^{-6} Risk)

will continue to work closely with the Office of Water Regulations and Standards in the latter Office's development of such water quality criteria for pesticides.

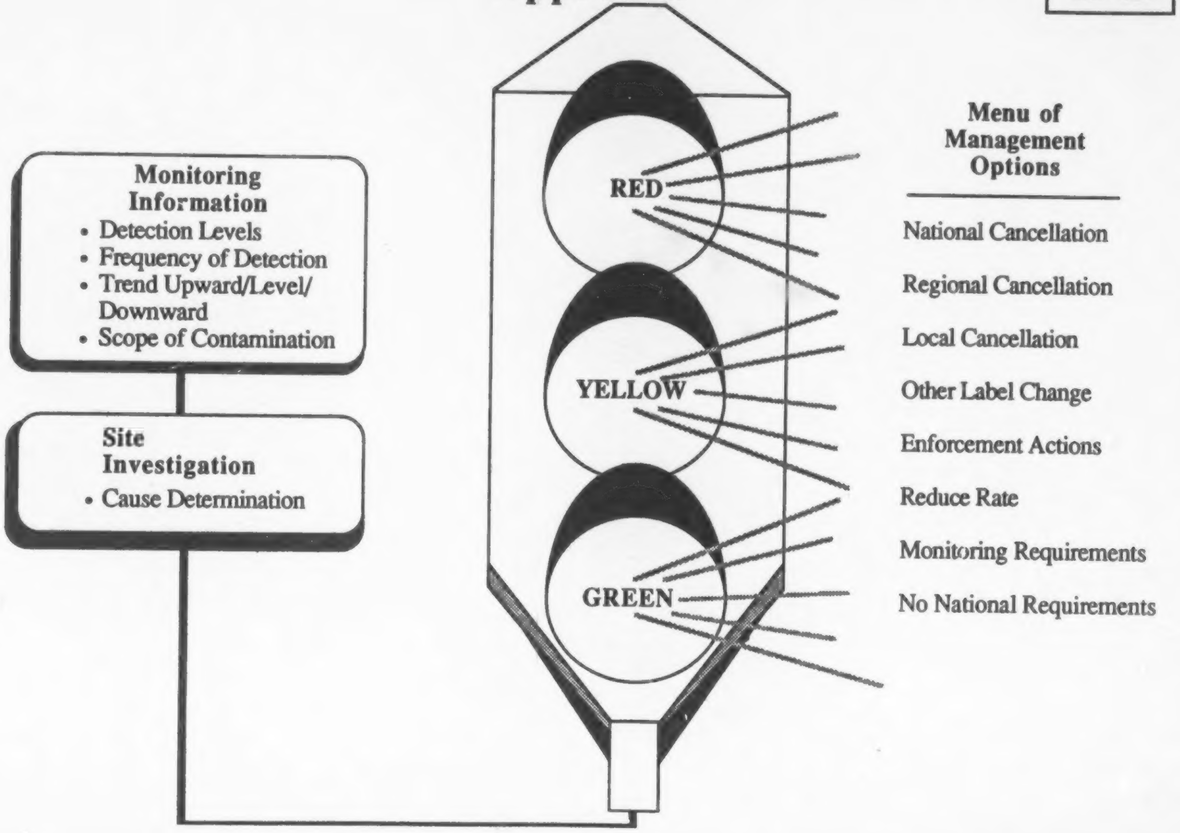
For response actions, the above criteria will be used as reference points to help determine where and what measures should be taken to protect human health and the environment should unacceptable levels of contamination be reached. Contaminated ground waters that are current or potential sources of drinking water or ground waters of ecological significance are all possible candidates for corrective efforts. Highest priority attention, however, should be given to responding to incidents of ground-water contamination where levels exceed an MCL or an interim reference point and that water is used as a current drinking water source.

For prevention efforts, the protection criteria, described above, will be used as reference points for helping to define unacceptable levels of contamination and to determine when certain pesticide management actions may be needed to reduce the likelihood of ground-water contamination reaching or exceeding such levels. Efforts to manage a pesticide's use will begin with early indications of its potential to contaminate ground water. These early indications can be based on information about the physical and chemical properties of the pesticide, how and where it may be used, and predictions of its fate in certain usage areas.

When a pesticide is found in ground water that is a current or potential drinking water source, additional management actions may need to be triggered. The need for, and the stringency of, these management actions will depend on the number of sites where the pesticide is detected, and whether the levels found are above or moving toward a reference point. In effect, EPA intends to establish an "early-warning" or "yellow light/red light" management process (Figure II-11), whereby increasingly stringent control measures will be applied in response to an increasing threat of a pesticide reaching or exceeding an unacceptable level.

Figure II-11

EPA's "Yellow Light/Red Light" Approach


Monitoring Information
• Detection Levels
• Frequency of Detection
• Trend Upward/Level/Downward
• Scope of Contamination
Site Investigation
• Cause Determination
RED
YELLOW
GREEN
Menu of Management Options
National Cancellation
Regional Cancellation
Local Cancellation
Other Label Change
Enforcement Actions
Reduce Rate
Monitoring Requirements
No National Requirements

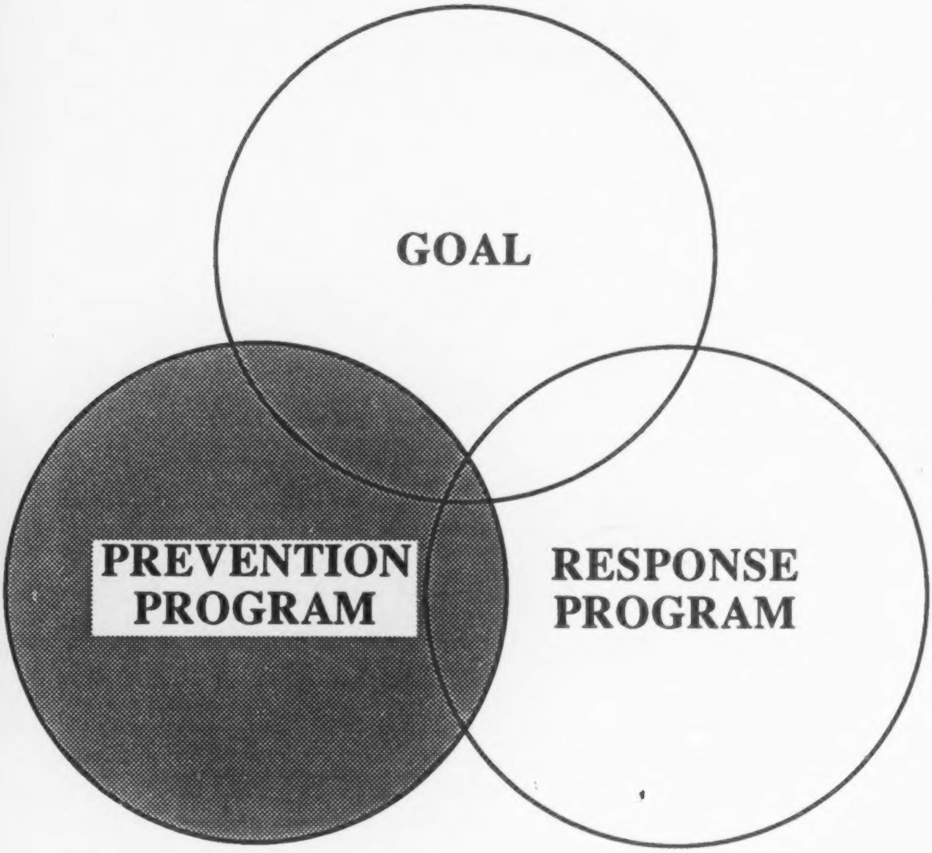
EPA's rebuttable presumption will be that the risks posed by pesticide contamination of a local underground source of drinking water, at or above the MCL or an interim reference point, will be more significant than the benefits derived from the pesticide's use in the area. Depending on the frequency and scope of such contamination, EPA will consider the cancellation of the pesticide's use in such areas as an appropriate response. However, a number of factors would need to be consider that could make cancellation inappropriate. For example, the benefits of using the pesticide in an area could be substantial and there may be management measures, other than cancellation, that could reduce contamination to acceptable levels. Also, the cancellation of a pesticide's use would not be appropriate if the ground-water contamination resulted from unusual circumstances such as an accident.

Before taking action to mitigate ground-water contamination threats, EPA must also consider such action in the context of overall pesticide exposure risks, including risks to applicators and farm workers and risks to the general population through dietary exposures. The Agency will maintain its regulatory flexibility to delay or modify ground-water protection measures should the Agency find that pesticide substitutes or alternative use practices would result in greater overall pesticide risks.

In conclusion, EPA's proposed goal is to protect the ground-water resource with specific attention given to preventing unacceptable contamination of current and potential drinking water supplies or ground water of ecological importance. Additional measures may be required to provide further assurances that certain "high priority ground waters" are not threatened by such contamination.

EPA will use MCLs, as defined under the SDWA, as its basic point-of-reference for determining unacceptable contamination for ground waters that are current and potential drinking water supplies. When no MCL exists, EPA will use an MCLG or its equivalent for noncarcinogenic pesticides and a negligible risk level for carcinogenic pesticides as interim reference points. The Agency will also use ecologically based protection criteria as reference points for determining unacceptable ground-water contamination.

Pesticide Strategy



GOAL

PREVENTION PROGRAM

RESPONSE PROGRAM

PROPOSED STRATEGY

CHAPTER 2

PREVENTION POLICY AND PROGRAM

Prevention of pesticide contamination of ground water is the centerpiece of the Agency's strategy for protecting ground water. As part of its prevention strategy, EPA will employ a multi-prong approach to prevent pesticides from reaching an unacceptable level in ground water.

First, EPA will take uniform action for pesticides posing widespread national concerns and will establish generic requirements for certain pesticide use and disposal practices that pose unique ground-water threats independent of area-specific ground-water conditions.

Secondly, EPA will adopt a differential approach to the management of pesticide availability and use. Under this approach, prevention measures will be tailored to an area's ground-water conditions to the extent feasible. Certain State-wide or county-wide measures will be required by EPA. Additional site-specific measures may be required in which the user will be responsible for determining their applicability to a given application site based on site-specific ground-water vulnerability or the user's location in an area of "high priority ground water" (i.e., high-use/value ground waters).

Third, the Agency will encourage a strong State role in the local management of pesticide use. Under this approach, a State will have the opportunity to develop a pesticide management plan that may be the basis for EPA's registration of a pesticide within that State. While the basis of a State plan must be to meet EPA's goal of protecting ground-water resources, a State will have flexibility in its management approach to better tailor measures to local needs.

Pesticide users and registrants will also continue to have key roles in protecting ground water. The users will be responsible for complying with label instructions and keeping informed of ways to prevent ground-water contamination, while the registrants will be responsible for monitoring certain ground waters and improving communication to the users on proper use of their products. Monitoring will play a major role in the prevention program by identifying potential contamination problems early and triggering appropriate pesticide management actions.

The next section discusses the options and factors that the Agency considered in developing its prevention strategy. Following this section is a detailed presentation of the Agency's proposed position on key aspects of the prevention approach.

SECTION 1: FACTORS AND OPTIONS CONSIDERED

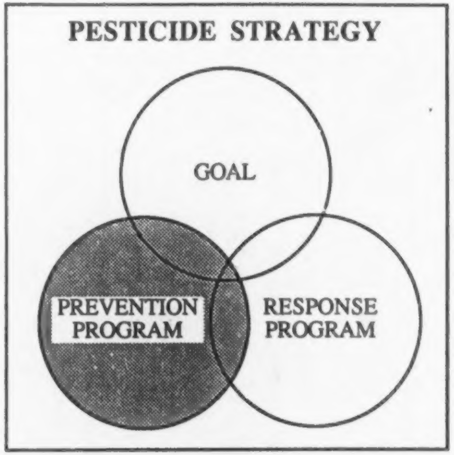
In designing its program for preventing ground-water contamination by pesticides, the Agency addressed two strategic questions: (1) how to address local variability and (2) what are the appropriate Federal-State roles (Figure II-12). An important consideration, related to the latter issue, was determining the role of the pesticide user and registrant in ground-water protection. Another key consideration was how to control further contamination of ground water once a pesticide has been detected in an area.

1. How to Address Local Variability

Since 1970, EPA has been responsible for regulating the use of pesticides in the environment. Through its regulatory programs under FIFRA, the basic pesticide law, the Agency has developed a number of tools for controlling pesticide use in the United States. Foremost among these tools is the authority to require extensive environmental and toxicological testing of pesticides. Through its registration and reregistration programs, EPA can require the manufacturer, or registrant, to conduct comprehensive testing of a pesticide, including environmental fate studies that will indicate the potential of a pesticide to leach into ground water.

Based on the results of these tests and other available data, the Agency approves or disapproves certain or all uses of a pesticide. When the Agency approves the use of a pesticide, it can further regulate the conditions of its use by imposing certain requirements or restrictions on the pesticide's labeling. Historically, the Agency has used product labeling as the major

Figure II-12


PESTICIDE STRATEGY
GOAL
PREVENTION PROGRAM
RESPONSE PROGRAM

Prevention Program Issues:

- How to Address Local Variability
- What Are the Appropriate Federal/ State Roles
- How to Control Contamination

vehicle for communicating information to the users regarding proper application and disposal of pesticide products. For those pesticides that pose significant risks but do not warrant complete removal from the marketplace, the Agency may impose labeling requirements that change the rate, timing, or method of application or that restrict its use to trained and certified applicators.

Under FIFRA, the States have the primary responsibility for enforcing the proper use of pesticides, as defined by the EPA-approved label. States may also require more stringent controls than the Federal Government for the use of pesticides within their individual States.

For dietary exposures and applicator or farm worker exposures, a uniform, national management approach is warranted. In the case of dietary exposures, differences among regions of the country are usually not significant since our food distribution system is national in scope. More important differences can be found among males and females or among infants, children, and adults because of differences in the diets of these subpopulations. Important differences also exist among these groups in their susceptibility to pesticide toxicity. For these reasons, the Agency generally evaluates the exposures from pesticides in the food supply based upon national averages for these subpopulations. Exposure to applicators or farm workers can also be regulated on a national basis by considering the physical-chemical properties of the pesticide and by requiring certain safety precautions on the label, such as protective clothing requirements.

Unlike dietary and applicator exposure, the pesticides in ground water concern does not lend itself easily to a uniform, national management approach. As previously mentioned, the use and value of ground water varies extensively across the country and as stated in the previous chapter, EPA will differentiate its protection efforts according to these differences. The vulnerability of ground water to pesticide contamination also varies substantially depending on such area-specific factors as the depth to ground water and the type of soil. Other factors that determine whether or not a pesticide will reach the ground water are local agricultural practices, the physical-chemical properties of the pesticides selected to deal with an area's pests, and how and when these pesticides are applied. A more detailed discussion of these factors can be found in the Problem Assessment of this strategy and in several other documents (e.g., Pesticides in Ground Water: Background Document, U.S. EPA 1986; Practices to Mitigate Contamination of Ground Water from Pesticides Used in Crop Production, U.S. EPA, in draft).

In addition to distinctions in management plans based on the use and value of ground waters, distinctions based on different vulnerability of ground water may be appropriate.

Figure II-13 illustrates an ideal approach to managing pesticides based on differences in ground-water vulnerability to contamination. Ideally, prevention measures would be tailored so that they provide the optimum level of protection without undue restrictions. Any protective measures above this optimum line for a given level of vulnerability would provide more protection than is actually needed. Protective measures below this optimum line for a given level of vulnerability would provide less protection than is actually needed. This graph is used in the following presentation of three possible management approaches for addressing the variability in ground-water vulnerability:

> a) **Uniform Approach** - A uniform approach essentially ignores area variability in vulnerability and applies the same prevention measures uniformly to all areas. If EPA relied on a uniform national approach to prevent ground-water contamination by pesticides, it would have to decide if its prevention decisions should be based on a worst-case situation of high vulnerability (Figure II-14a) or on a moderate case of medium vulnerability (Figure II-14b).
>
> A worst-case basis could result in a great deal of overprotection for less vulnerable areas, while a moderate-case basis could result in both overprotection of low-vulnerability areas and underprotection of high-vulnerability areas. The obvious drawback of underprotection is the likelihood of ground-water contamination exceeding acceptable levels as defined by EPA's environmental goal. The problem with overprotection is that it could result in the loss of valuable pesticide uses in important farming areas of the country -- a situation that would not be compatible with the intent of FIFRA.

Figure II-13

"Ideal" Protection

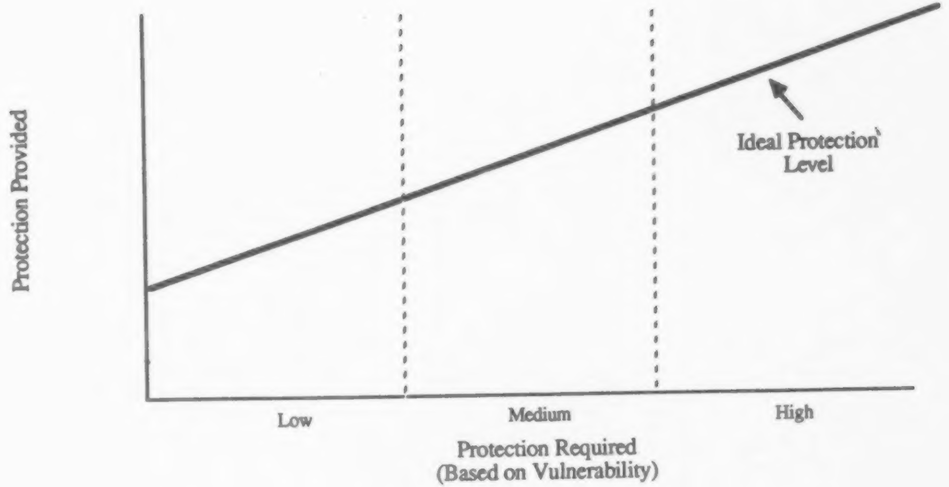
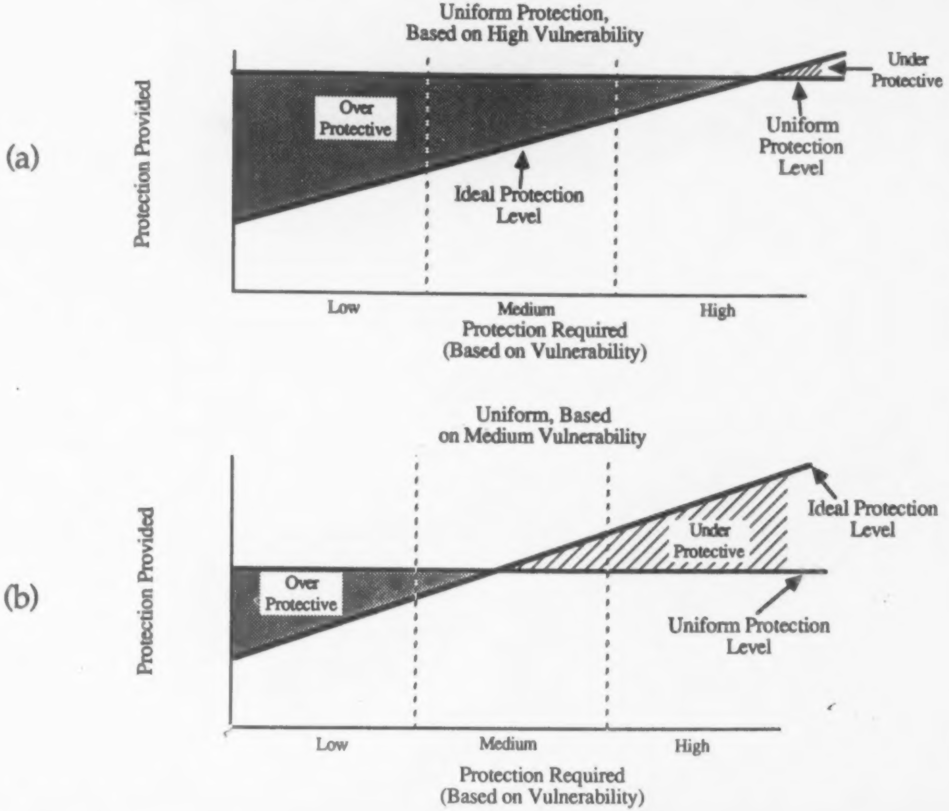


Figure II-14.

Vulnerability-based Uniform Approaches


(a)
Uniform Protection,
Based on High Vulnerability
Protection Provided
Over Protective
Ideal Protection Level
Uniform Protection Level
Under Protective
Low
Medium
High
Protection Required
(Based on Vulnerability)
(b)
Uniform, Based
on Medium Vulnerability
Protection Provided
Over Protective
Under Protective
Ideal Protection Level
Uniform Protection Level
Low
Medium
High
Protection Required
(Based on Vulnerability)

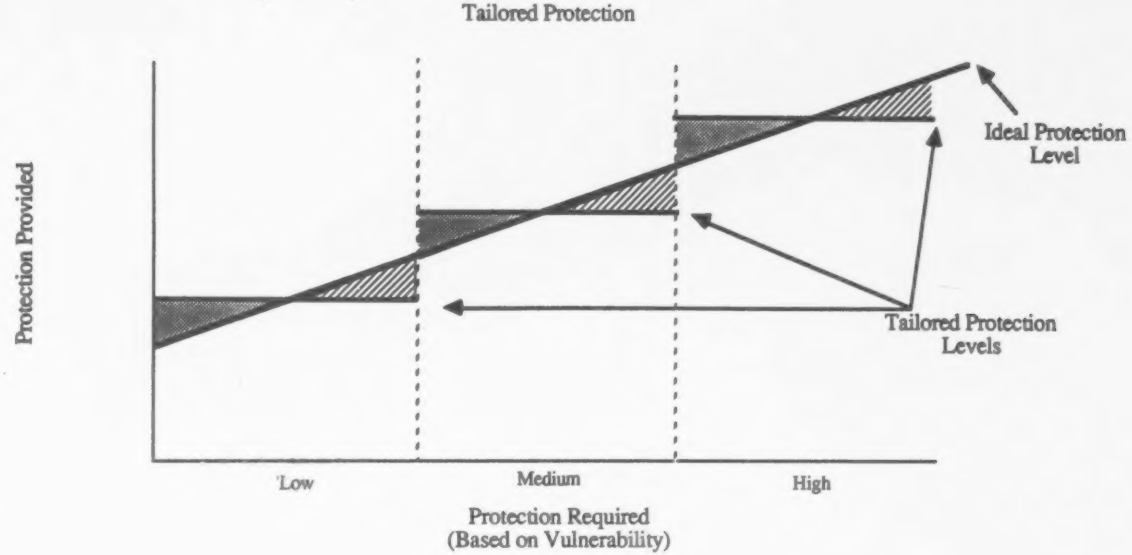
b) **Uniform Baseline Prevention Measures with Local Exemptions and Additional Special Measures** - Under this option, uniform baseline measures would be established for a pesticide in the same manner as the above option, but area-specific exemptions would be allowed for those places that would otherwise be overprotected. Such an approach could be implemented through a permit system in which exemptions from baseline requirements would be allowed for less vulnerable areas. Additional special measures could be applied on a case-by-case basis to those areas that would otherwise be underprotected. These additional measures could be specified on a label and the user made responsible for determining if they are applicable to the user's particular area.

While addressing some of the concerns for overprotection and underprotection of the previous option, this approach has some major limitations. A permit system carries major administrative costs and can place significant burdens on pesticide users. It would be highly impracticable for EPA to operate a national system of area-specific permits. Having the user determine the applicability of more restrictive measures could result in compliance problems. The user may not have the training to determine if the user's area is more vulnerable than the general case and, therefore, underprotected by the uniform measures.

c) **Differential Approach** (Figure II-15) - A third approach for addressing area variability is to tailor prevention measures to different levels of ground-water vulnerability. The number of vulnerability levels is practicably limited by: (1) the technical ability to accurately differentiate vulnerability; and (2) the number of different prevention measures that could reasonably be used to provide differential protection. Figure II-15 divides ground water into three different vulnerability levels. A different degree of stringency in prevention measures is then applied to each of these three levels of ground-water vulnerability. While there is still a likelihood of underprotection and overprotection measures for any given area, the number of such measures would be reduced in comparison to the first two options discussed above.

Figure II-15

Tailored Preventive Measures Based on Vulnerability



This option requires the designation and mapping of specific areas, based on ground water vulnerability, as well as the development of differential measures for each level of vulnerable ground water. The success of this option depends to a large extent on the degree of resolution (i.e., county, farm, acre, etc.) in designating and mapping local vulnerability. Note that such mapping would be in addition to mapping of ground waters by their use and value.

Vulnerability to pesticide contamination may be fairly uniform across some large areas, while in other areas it may vary on a farm-by-farm basis or even on an acre-by-acre basis. Figure II-16 presents the different degrees of resolution that could be used as the basis for differentiating agricultural areas by relative vulnerability. At one end of the spectrum is resolution at the national level, which as previously described is the Agency's basis for addressing dietary and applicator exposure concerns. At the other end of the spectrum is resolution at the level of individual acres. Although making determinations of vulnerability at the highest degree of resolution would be the preferred technical basis for management, the sheer number of decisions required by such an approach could be overwhelming (See Figure II-17). EPA may be able to manage a differential approach to pesticide use at one degree of resolution, whereas a State may be successful in conducting a management program at a much higher degree of resolution. A State should also be in a better position to make decisions on the use and value of ground water in a given location. Who should determine the vulnerability and the use and value of ground water in an area and who should manage a differential approach are the subjects of the second strategic question.

2. What Are the Appropriate Federal/State Roles?

The options the Agency has considered for Federal and State roles in addressing ground-water contamination using a differential approach are as follows:

Figure II-16

Level of Resolution

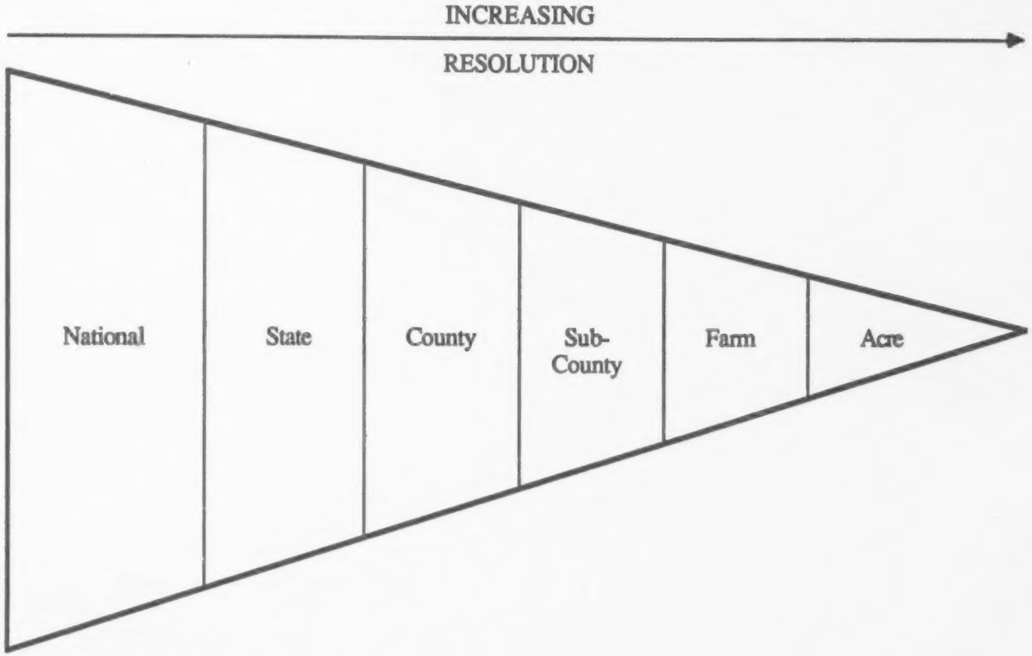
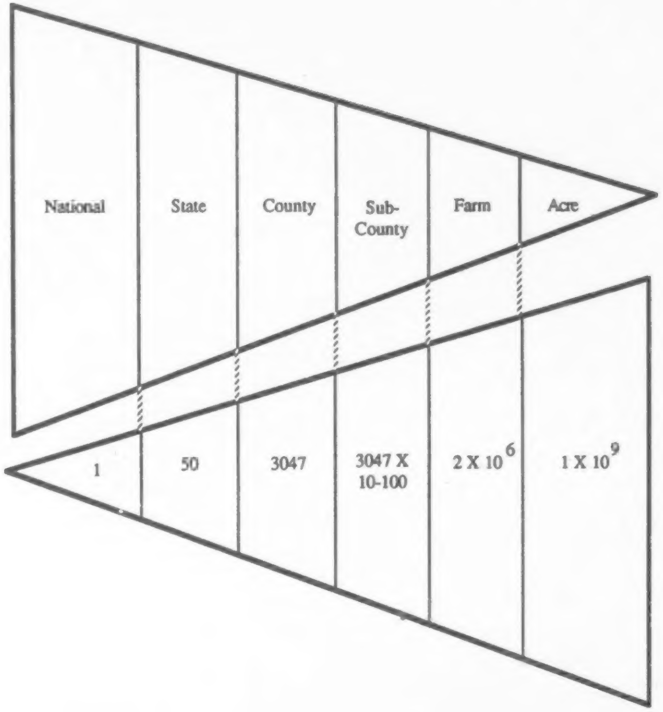

INCREASING
RESOLUTION
National
State
County
Sub-County
Farm
Acre

Figure II-17

Level of Resolution


National
State
County
Sub-County
Farm
Acre
1
50
3047
3047 X 10-100
2 X 10^6
1 X 10^9

a) **EPA Establishes Differential Measures/User Determines Applicability** - In this approach (Figure II-18), the Agency would establish differential protective measures for a pesticide based on ground-water use and value considerations and/or different levels of vulnerability of the ground water where the pesticide is being used or proposed for use. The Agency may decide that certain pesticides cannot be used in areas of high use and value and/or high vulnerability. For moderately vulnerable areas, the use of the pesticide could be subject to special restrictions, such as changes in the rate, timing, or method of application. Furthermore, representative monitoring of ground water for the pesticide in these moderately vulnerable areas could be required of the registrant to ensure that no threat of unacceptable contamination emerges. For low vulnerability areas, special ground-water protection measures might not be required, although there might be applicable generic requirements, such as a requirement for special measures near drinking water wells.

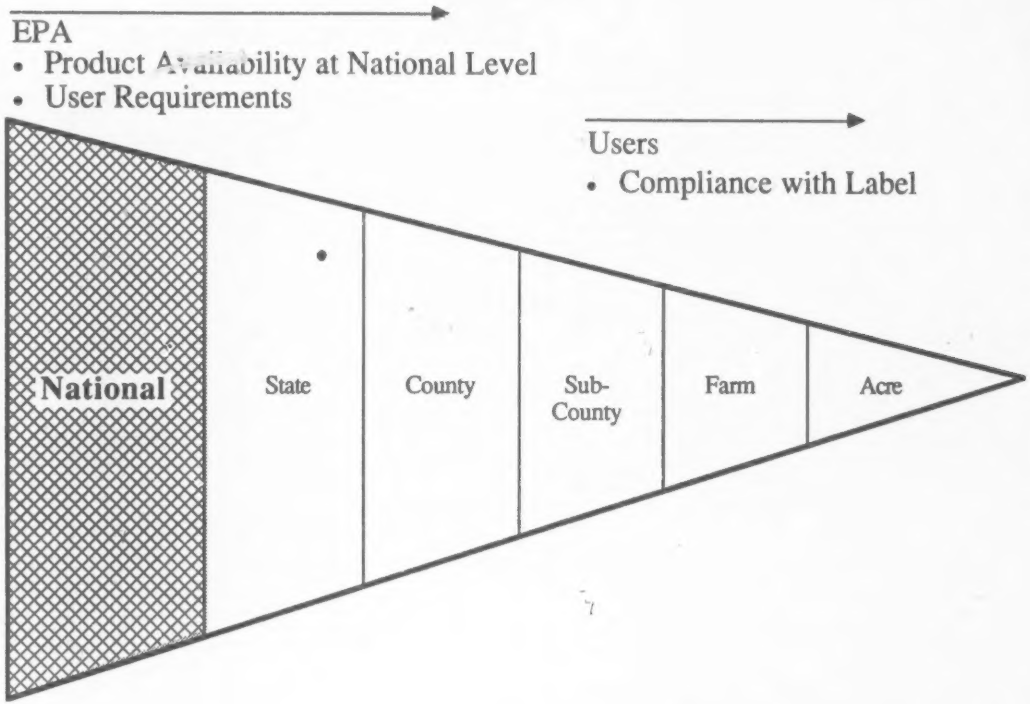
An important characteristic of this option is that the user would be primarily responsible for determining the applicability of differential requirements based on a required assessment of local vulnerability and the user's location within an area of "high priority ground waters." The user would base a decision on label directions and possibly on supplemental instruction or training. One problem with this option is that most users do not have the scientific background in hydrogeology or environmental fate processes to make accurate field decisions. With this option, directions must be provided that translate technical assessments of ground-water vulnerability into directions that a user can understand and apply. However, determinations of ground-water vulnerability to pesticide contamination are very complex, and simple but effective label directions for users are difficult. Because of these constraints, implementing this option could likely result in misuse and possible unacceptable contamination of ground water.

b) **EPA Specifies Differential Measures for Individual Counties or States; Users Determine Applicability of EPA-Specified Sub-County Measures** (Figure II-18b) - As with the previous option, the Agency would develop differential prevention measures based on ground-water use and value and/or

Figure II-18a

Roles and Responsibilities

Option "A"



EPA
- Product Availability at National Level
- User Requirements

Users
- Compliance with Label

National
State
County
Sub-County
Farm
Acre

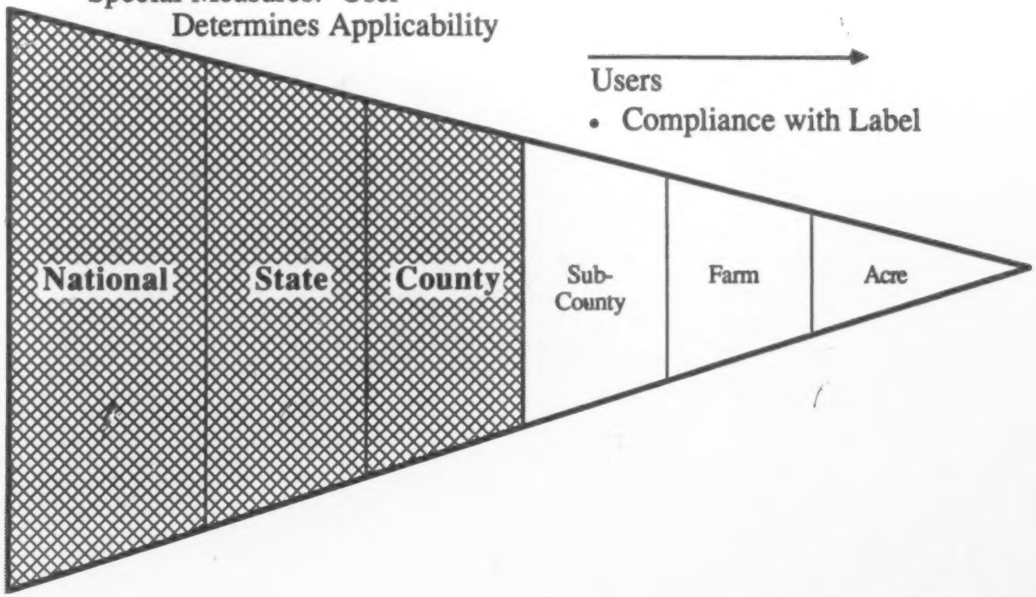
Figure II-18b

Roles and Responsibilities

Option "B"

EPA
- Product Availability at National, State, or County Level
- User Requirements
  - -- National, State, or County Measures
  - -- Special Measures: User Determines Applicability

Users
- Compliance with Label


National
State
County
Sub-County
Farm
Acre

different degrees of vulnerability, but in this option the Agency would identify or map vulnerability areas on a county basis. This information would be provided to the user on the label, supplemental labeling, or by other means.

While EPA's designation of ground-water vulnerability could be based on sub-county assessments, the actual management of pesticide use could only occur, at best, at the county level because of administrative factors, such as labeling constraints and enforcement considerations. In fact, there might be certain situations in which EPA would decide to apply the same protection measures to an entire State as a result of these administrative difficulties. At this level of resolution, EPA would base minimum county- or State-wide measures on the assumption that all ground waters in the area are, at least, a current or potential drinking water source.

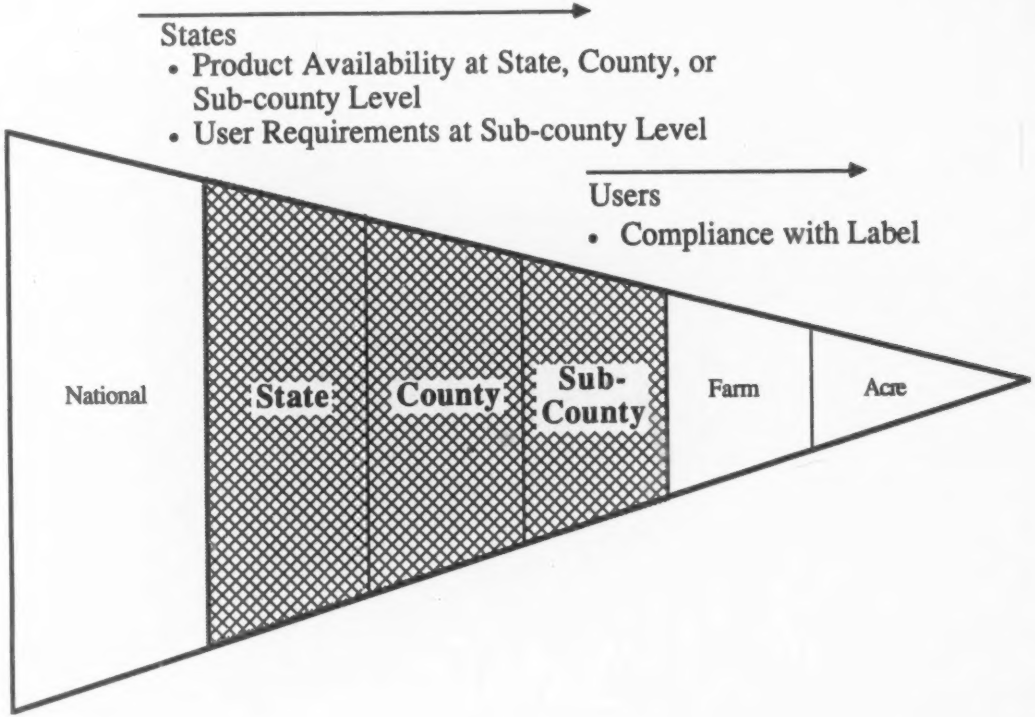
Since the vulnerability within a county can vary greatly, this approach could unnecessarily apply stringent measures, including local bans, to sub-county areas that are less vulnerable than the average for the county in which they are located. Similarly, such variation could result in underprotection for sub-county areas more vulnerable than a county average. This latter possibility could cause the Agency to make overly conservative decisions when classifying counties based on vulnerability. As with the first option, the user would be required to make difficult location-specific judgments on the applicability of prevention measures that would be more stringent than the minimal county-wide requirements because of site-specific vulnerability or the user's location within an area of "high priority ground water."

c) **State Specifies Differential Measures for Sub-County Areas Based on EPA Criteria** (Figure II-18c) - With this option, the State would have the dominant role in determining differential prevention measures, but such measures would be based on EPA criteria. The States would identify and map their ground waters in terms of use, value and vulnerability and provide pesticide users with explicit directions on where and how pesticides could be applied.

Figure II-18c

Roles and Responsibilities

Option "C"



States
- Product Availability at State, County, or Sub-county Level
- User Requirements at Sub-county Level

Users
- Compliance with Label

National
State
County
Sub-County
Farm
Acre

The States should be able to provide a differential management approach based on highly-specific area designation of ground-water vulnerability, use and value. As such, the user in the field would have more explicit directions as to where and how the pesticide could be used, and would not have to determine local vulnerability. Another advantage to this option is that the State could also closely tie user training and enforcement efforts to its own differential approach.

Although the States are in a better position than EPA to understand local conditions and establish a differential approach that is highly tailored to these conditions, there are a number of drawbacks to this option. These include the potential lack of uniformity among States and possible political and legislative constraints within particular States, which may jeopardize obtainment of EPA's environmental goal of protecting the ground-water resource. The option could also result in the inefficient use of State resources because of unnecessary duplicative efforts in developing pesticide prevention measures.

SECTION 2: EPA'S PROPOSED POSITION

EPA will employ each of the three basic management approaches, described above, to prevent pesticides from reaching unacceptable levels in ground water. EPA will continue to develop uniform, national measures, but will also begin to implement a differential management approach at the county level or, in some cases, at the State level. A State will have the opportunity to take a stronger role in local pesticide management through the development of a State management plan. The responsibilities of pesticide users and registrants will grow along with an increasing reliance on monitoring information.

EPA's specific strategic policies are as follows:

1. EPA will continue to take uniform action for pesticides causing widespread, national concerns and will establish generic prevention measures to address certain pesticide use

and disposal practices that pose ground-water threats independent of area-specific vulnerability. National uniform measures will not be differentiated on the basis of local differences.

Obviously, when a pesticide's use poses a serious, widespread ground-water threat, EPA will take steps at the national level and, if necessary, impose a regional or even a national cancellation of the use of the pesticide. Of particular national concern are those general ground-water threats that are not dependent on local vulnerability and require generic prevention measures. For example, EPA has proposed regulations for the application of pesticides through irrigation waters, often referred to as chemigation. This practice can directly introduce pesticides into ground water if precautions, such as anti-back siphoning devices, are not used.

EPA is also developing a rule to restrict the use of potential leaching pesticides to certified applicators. The Agency is also considering the development of national rules to address the potential problem of pesticide applications too near a well which can result in "run-in" of pesticides into ground water, a particular problem in areas with uncapped, abandoned wells. Finally, EPA is considering additional generic rules and guidelines for pesticide disposal and for preventing and handling leaks and spills, all of which can be important sources of a number of pesticide concerns, including ground-water contamination. For the disposal concern, EPA is looking at its options under both FIFRA and RCRA.

2. EPA will also adopt a new approach of differential management of pesticide use based on differences in ground-water use, value and vulnerability to an extent that is administratively feasible. County- or State-level measures based on ground-water vulnerability will be employed, including use cancellations. In some cases, the user will have to determine the applicability of differential prevention measures based on interpretation of local field conditions and the user's location within areas of "high priority ground waters."

When a pesticide poses serious but localized risks due to local ground-water vulnerability, an appropriate prevention approach is to remove the threat where it exists and allow the use of the pesticide in other areas to continue without undue restrictions. EPA's prevention measures will thus be differentiated in their stringency on the basis of relative vulnerability of local ground water to pesticide contamination. Because of a number of administrative limitations, as mentioned earlier, EPA's prevention measures will generally be differentiated at the county or State level. EPA will do its best to assess the vulnerability of pesticide usage areas within counties and to determine the appropriate mix of prevention measures necessary to protect ground waters within the entire county. At this level of aggregation, EPA will have to assume that all ground water, at a minimum, is a current or potential drinking water source requiring protection.

Prevention measures will include minimum, county-wide requirements that must be followed by all users within a designated county. For some counties, the minimum measure may be a ban on a pesticide's use. For other counties, the pesticide's use will be allowed, but minimum county-wide measures will range from general advisories to extensive requirements involving changes in the rate, timing, or method of application or other agricultural practices that can influence pesticide movement to ground water. Additional measures, beyond minimum county-wide requirements, could also be required of users in certain areas of a county. The determination of the applicability of these additional measures will be the responsibility of the user and will be based on site-specific factors, such as the presence of ground-water conditions more vulnerable than generally found in a county or the need to protect certain "high priority ground waters," such as those within a drinking water wellhead protection area.

In some cases, EPA may apply minimum prevention measures, including geographic bans, to an entire State. Such a situation may occur where there is generally uniform ground-water vulnerability to contamination by a pesticide in all usage areas of a State. State-wide measures could also occur where EPA believes the State does not have the ability to support a differential approach to the management of pesticides, particularly from enforcement and user education perspectives.

3. EPA will encourage the development of a strong State role in area-specific management of pesticide use to protect the ground-water resource. State pesticide management plans will be used to strengthen EPA's foundation for decisions on pesticide use. In some cases, the use of a pesticide in a State will depend on the existence of and adequacy of such a State management plan. Under its management plan, a State will develop and implement highly tailored prevention measures based on local differences in ground-water use, value and vulnerability.

As discussed earlier, there are a number of limitations to an EPA-directed differential management approach for pesticides at the county or state level. Such an approach can prohibit or restrict the use of a pesticide unnecessarily in some areas. This approach also places a major burden on the user to determine the applicability of more restrictive measures that are based on site-specific conditions that the user must assess. These disadvantages could result in noncompliance and a failure of this approach to meet EPA's environmental goal of protecting the ground-water resource. Therefore, the Agency is looking for strong State involvement to determine where a pesticide can, and cannot, be used without ground-water restrictions. This alternative cooperative approach between EPA and a State will lessen the burden on the user to determine the applicability of site-specific measures, and in turn, reduce noncompliance and increase the likelihood of attainment of EPA's environmental goal.

States often can have the technical expertise and have more specific knowledge of local ground-water conditions and agricultural practices than EPA. States are also likely to be in a better position to work more directly with the user to ensure that potential ground-water contamination problems are identified and that pesticides are properly used to avoid these problems. EPA wants to strengthen and utilize the unique position of the States in efforts to prevent ground-water contamination by encouraging the States to develop pesticide management plans to protect their local ground waters.

Under a State management plan, the State would identify where a pesticide with ground-water contamination concerns is being used or is likely to be used. The State would also use its knowledge of local ground-water resources and determine where protection measures would be differentiated based on local differences in the use and value as well as the vulnerability of ground waters. The State would adopt prevention measures that would prevent unacceptable contamination of current and future drinking water sources as well as ground waters that are ecologically important. As part of its management plan, the State could also identify areas with "high priority ground waters," such as wellhead protection areas, where more stringent measures may be required.

In some cases, the State would obviously have to employ EPA-designated measures for certain types of areas, such as local cancellations of high risk pesticides in highly vulnerable ground-water areas. However, it is EPA's intent that a State generally have the opportunity to select from a broad menu of management measures (Table II-1) and to tailor prevention to local needs. Some of these measures may be Best Management Practices (BMPs) which have been developed and demonstrated by a state, perhaps under EPA's Nonpoint Source Program. Those measures which are chosen by a State will have to be supported by strong, coordinated education and enforcement programs.

Development and implementation of a State management plan will require the active participation of all key state agencies including the departments of agriculture, public health, water, natural resources, or environmental protection. A State's pesticide management plan will be a key component of its overall ground-water protection strategy and should be consistent with its Wellhead Protection Program, if one exists. The State should take a holistic approach to protecting its water resources and realize the important relationship between ground-water protection and surface water quality. The State pesticide management plan should be consistent with any State clean water strategy for protecting surface waters.

Table II-1

State Management Menu

Pesticide Use

- Moratorium Areas
- Wellhead Protection Areas
- Well Set Backs (Buffer Zones)
- Future Well Requirements: Location, Depth, Construction
- Change in Rate of Application
- Change in Timing of Application
- Change in Method of Application
- Advance Notice of Application
- Integrated Pest Management
- Best Management Practices
- Additional Monitoring
- Additional Training and Certification

When deciding on the national registration of a pesticide with ground-water contamination concerns, EPA will consider a State's management plan. EPA will work with each State to determine if a pesticide's use can be managed locally by the State to prevent or reduce the threat of ground-water contamination. In some situations, EPA will require a State-specific label or supplemental labeling with the approved conditions of use based on a State management plan. In other cases, EPA will have to take steps, including possible State-wide cancellations, to control the use of a pesticide that poses a significant ground-water threat if there is no adequate State management plan that can reasonably be expected to prevent or reduce the threat of unacceptable contamination.

While over the longer-term, States may develop generic management plans that can be applied to any specific pesticide, the Agency expects that the States will adopt chemical-specific management schemes for those pesticides that pose major ground-water risks. As EPA and the States gain practical experience with the concept of State management plans, and as our understanding of approaches for mitigation of pesticide contamination increases, the need for chemical-specific schemes may diminish.

Development of a management plan does not necessarily have to be accomplished by each State acting alone. Where ground-water resources are continuous under State boundaries and contamination problems in one State could threaten the quality of waters of another State, it would make sense for adjacent States to coordinate their State plan development. In the case of chemical-specific schemes, certain States may also find multi-State or regional management schemes desirable to obtain or continue EPA's registration of a pesticide that is important to a regional crop.

One of EPA's key responsibilities under this approach will be to provide as much technical support to the States as possible, including information on the physical/chemical/toxicological characteristics of pesticides of concern and their behavior in the environment. To meet this responsibility, EPA will keep abreast of monitoring information to detect new pesticide contamination concerns as well as to assess the effectiveness of various management approaches. The Agency will also keep the States informed of national trends and will facilitate exchange of information between the States on the problems and successes of different local management approaches. Through the Office of Ground-Water Protection's Wellhead Protection Program, and through several CWA grant programs, including the nonpoint source authorities, EPA will provide financial and technical support to States for the development and implementation of their State management plans. The Agency will also coordinate with other Federal agencies, such as USDA and USGS, to conduct research and to communicate results to the States on pesticide behavior, monitoring methods, best management practices, and other technological information needs.

Table II-2 provides scenarios for how pesticides that pose a moderate to high ground-water threat would be managed in States with different vulnerability situations. Two options are presented: 1) no State plan; and 2) State plan in place.

4. The user's role in preventing ground-water contamination is pivotal; the user's decisionmaking in the field must be better supported.

Regardless of whether a pesticide is managed under an EPA-State cooperative management approach or an EPA-only approach, the user will continue to be in the unique position of directly controlling the use of pesticides in the field. Thus, the user has the responsibility to seek better understanding of ground-water concerns. At a minimum, a user must follow the instructions found on the label of each pesticide product and when required, be trained and certified in the proper use of the pesticide.

However, we cannot expect the typical pesticide user to make highly technical decisions on his own. The best approach is to provide the user with clear instructions either to not use a pesticide or to use it in a certain manner in highly specified areas. Such areas should be familiar to the user, or a map should be provided that clearly delineates the area. To some degree, a State's management plan should have the capability to provide such specificity.

Table II-2

Comparison of Possible Outcomes for Pesticide Use in a State

Situation	No State Plan	State Management Plan
High-risk pesticide State has extensive high-vulnerability areas	Probable statewide cancellation	Possible special state management measures in lieu of EPA cancellation
High-risk pesticide State has mixture of high- to moderate-vulnerability areas	Possible statewide cancellation Probable county cancellations County-based use requirements Other use requirements[1] Monitoring requirements	Possible county cancellations Area-specific use moratoriums Area-specific use requirements Monitoring requirements
Moderate-risk pesticide State has primarily moderate-vulnerability areas	Possible county cancellations County-based use requirements Other use requirements Monitoring requirements	Possible area-specific use moratoriums Area-specific use requirements Possible monitoring requirements

[1] These requirements include measures for protection of "high-priority areas" such as within the immediate vicinity of drinking water wells. It also includes generic prevention measures such as those required for chemigation practices. Finally, these requirements include those measures that the user would have to determine are needed in an area based on a required assessment of the ground water of the specific site.

However, as discussed earlier, the area-specific nature of ground water could still require the user to identify vulnerable ground water in the user's specific fields and to determine if special prevention measures are needed. This will be especially true where the State has not taken an active management role. There are no easy formulas to provide exact "answers" to the user through label instructions alone. The Agency recognizes that it and the States must provide better support to the user for making proper use decisions. USDA, with its existing field network, also can play a key role.

A major vehicle for improving user decisions in the field is applicator training and certification programs. EPA is establishing a generic rule for restricting the use of those pesticides with potential ground-water threats to certified applicators. Working with the States and the Cooperative Extension Service, EPA is attempting to improve and expand training and certification programs so that users may become more aware of ground-water concerns and the measures necessary to protect this vital resource.

5. Registrant responsibilities will need to grow in three areas: (1) technical support for the user in the field; (2) ground-water monitoring to ensure the adequacy of pesticide management plans in protecting ground water; and (3) the development of safer alternative pesticides.

While there are State and Federal programs that can shoulder some of the need, registrants will need to play a greater role in assisting the user in the proper, environmentally sound application of their products.

In the future, registrants will also be expected to conduct representative monitoring of ground water in areas where pesticide use occurs and where ground water may be vulnerable. These studies will be critical to ensure that protection efforts are working. Where there is a potential ground-water contamination concern, certain new registrations may be granted on the condition that the registrant conduct monitoring studies. Continued registration of certain pesticides, under a State management plan, may also hinge on monitoring data to

Table II-3

Responsibilities in the Strategic Prevention Approach

EPA	STATE
Responsibility Level: National, County or State ***Responsibilities:*** • Differential Preventive Measures -- Minimum Statewide or Countywide Requirements -- User Site Requirements • County, State, or National Cancellations • Generic National Measures for Pesticide Use • Oversight of State Plans • Technical Support to States • Labelling Requirements	***Responsibility Level:*** State, County or Sub-County ***Responsibilities:*** • State Management Plan -- Foundation for EPA Use Decisions -- Identify Pesticide Use Locations -- Classify & Map Ground Water Resources. Designate Vulnerability -- Tailor Prevention Measures to Meet EPA Goal • User Support • Monitoring
USER	**REGISTRANT**
Responsibility Level: Site Specific ***Responsibilities:*** • Additional Understanding of Ground Water Concerns • Close Adherence to Labels • Application Training and Certification as Necessary	***Responsibility Level:*** All ***Responsibilities:*** • Technical Support of User • Ground Water Monitoring • Safer Alternative Pesticides

indicate the environmental adequacy of those management efforts. Registrants may find it beneficial to pool their efforts to establish a joint and effective monitoring capability.

Finally, registrants will be expected to develop safer alternative pesticides that do not pose a threat to ground water. This message will become increasingly obvious to the registrants as the Agency and the States continue to restrict or cancel the uses of more pesticides that threaten the quality of the nation's ground waters.

6. Increased monitoring of pesticides in ground water is critical to the implementation of this strategy. EPA will establish an "early-warning," or "yellow light/red light," approach to prevent further area contamination, once detected. The approach will use the MCL or other EPA-specified protection criteria as the point of reference to evaluate, and when necessary, change pesticide management plans.

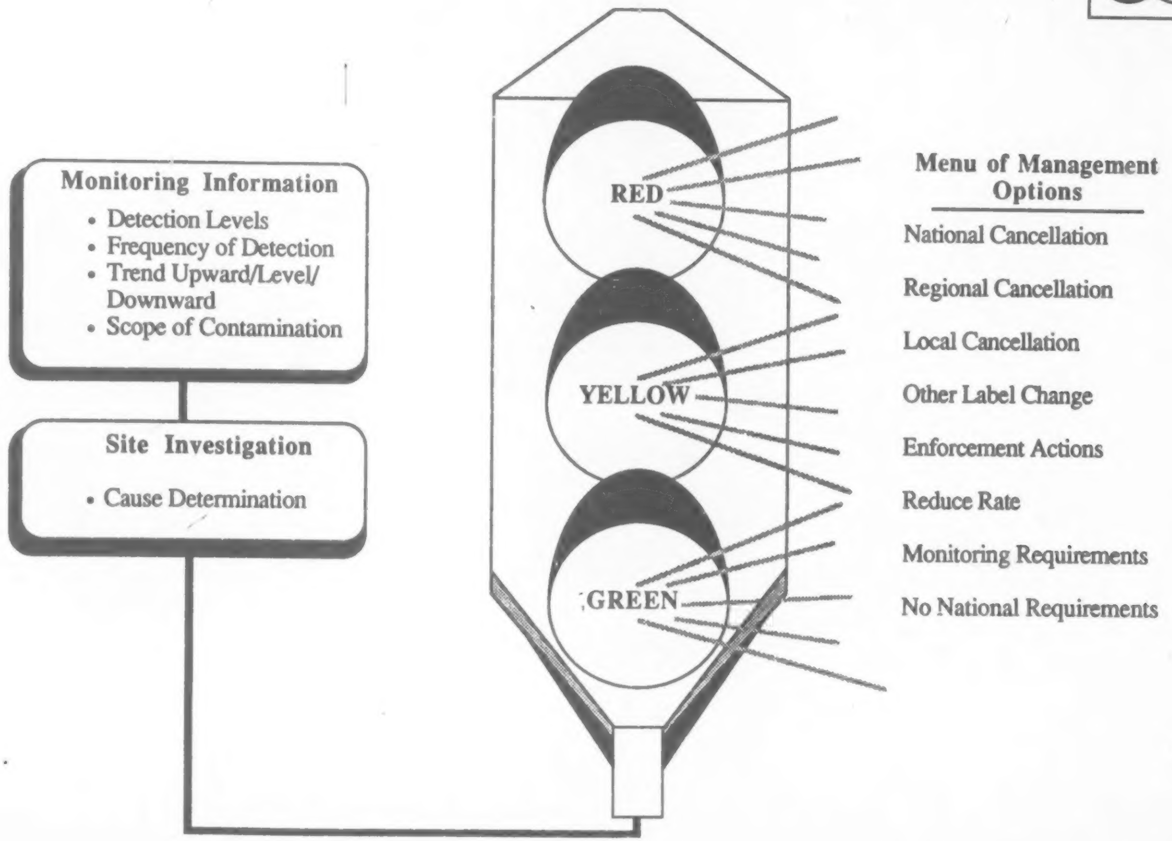
Even though the Agency has developed a number of models for predicting ground-water contamination, there is still a great deal of uncertainty in identifying the exact locations of areas vulnerable to contamination and in estimating the levels of contamination that could be reached in the ground waters of these areas. Thus, monitoring of pesticides in this environmental medium is a critical need that can provide the needed feedback to determine the success or failure of pesticide management efforts.

EPA or a State, under its management plan, will direct or conduct monitoring of pesticides in ground water that is representative of where the pesticide use occurs and where there is a potential ground-water problem. When pesticide contamination is found to be moving toward an MCL or other EPA-designated ground-water protection criteria, EPA or the State will revise the pesticide's management plan, as necessary, to prevent further contamination. The stringency of new measures will depend on the likelihood of contamination reaching or exceeding these reference points in current or future drinking water or ground water of ecological importance. Factors to be considered are the levels found, the number of contamination sites, whether the trend is upward, and the cause, if known (Figure II-19).

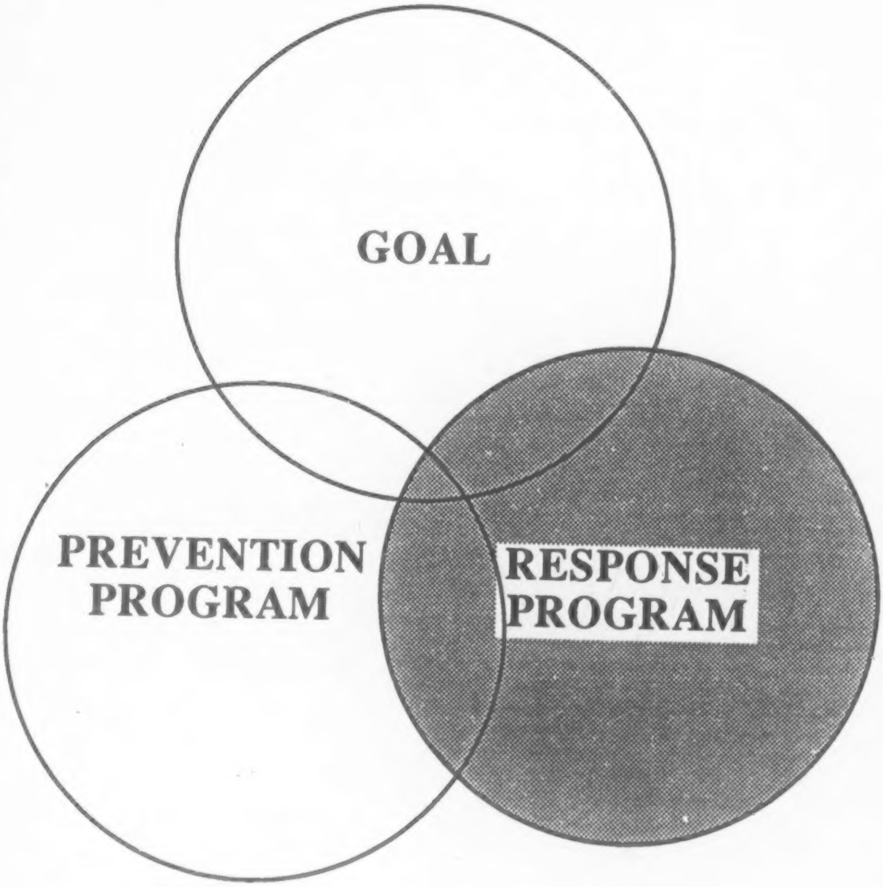
As discussed above, registrants will often be responsible for conducting monitoring in representative areas of a pesticide's use. The registrant may also be required to do site-specific monitoring in an area where contamination has already occurred if the registrant desires to continue the registration of the pesticide in that area or other areas with similar pesticide use characteristics and ground-water vulnerability.

Figure II-19

EPA's "Yellow Light/Red Light" Approach


Monitoring Information
• Detection Levels
• Frequency of Detection
• Trend Upward/Level/Downward
• Scope of Contamination
Site Investigation
• Cause Determination
RED
YELLOW
GREEN
Menu of Management Options
National Cancellation
Regional Cancellation
Local Cancellation
Other Label Change
Enforcement Actions
Reduce Rate
Monitoring Requirements
No National Requirements

Pesticide Strategy



GOAL

PREVENTION PROGRAM

RESPONSE PROGRAM

PROPOSED STRATEGY

CHAPTER 3
RESPONSE POLICY AND PROGRAM

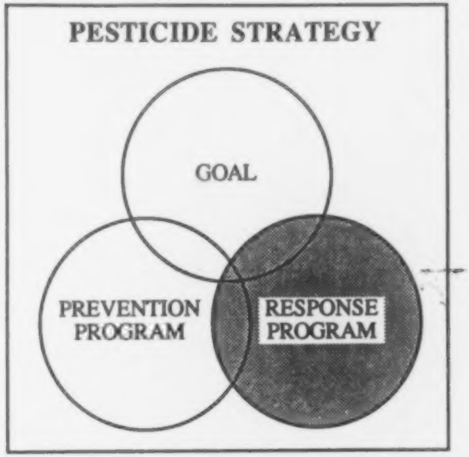
One of the most challenging tasks facing the Agency and the States is developing a strategy for responding to ground-water contamination resulting from normal use of pesticides. EPA's approach will be to work closely with the States in their efforts to remove public health threats. Where a pesticide has reached unacceptable levels, strong actions will be taken to prevent further contamination. The Agency will continue to emphasize the development and enforcement of MCLs to ensure the adequacy of drinking water from public water systems. In the future, the Agency will focus on coordinating enforcement activities under a number of Federal authorities so that responsible parties can be identified and required to take the actions necessary to eliminate imminent health threats. On a case-by-case basis, EPA will assist the States by providing funds for removal actions, including provisions of alternative drinking water, when a imminent public health threat exists.

SECTION 1: FACTORS CONSIDERED

To develop its response strategy, the Agency had to address three questions: what are the appropriate Federal/State roles; what are the appropriate authorities and actions for what type of contamination; and who is liable for contamination (Figure II-20). To address these questions, several site-specific conditions must be considered, including: the type of ground water affected, the source or circumstances that resulted in contamination, and the appropriate type and degree of response needed.

The type of ground water that has been contaminated is a critical consideration in determining both the level of concern and the authorities available to conduct or require a response action. For instance, the SDWA addresses only the contamination of public water systems, defined as those systems providing drinking water to 15 or more permanent service connections or 25 people a day for at least 60 days a year. Under the SDWA, public water systems are required to provide water satisfying drinking water standards (i.e., no contamination exceeding MCLs). Although SDWA regulations do not

Figure II-20


PESTICIDE STRATEGY
GOAL
PREVENTION PROGRAM
RESPONSE PROGRAM

Response Program Issues:

- What Are the Appropriate Federal/State Roles
- What Are the Appropriate Authorities and Actions for What Type of Contamination
- Who is Liable for Contamination

apply to private wells, most States use these or their own similar standards to inform well owners of possible health risks, and in some cases, State laws may require closure of private wells that do not meet drinking water standards.

The source and circumstances of contamination at a given site are other important considerations in determining the appropriate authority for responding to contamination. Under the Comprehensive Emergency Response, Compensation and Liability Act (CERCLA), EPA has the authority to clean-up contamination and recover the cost of these actions from responsible parties. Cost-recovery, however, is specifically excluded when the contamination is a result of pesticide use in accordance with label requirements. Recovery of cost from responsible parties is a possibility, however, when contamination is a result of illegal disposal or leaks and spills.

The type and degree of response must be based on the specifics of each case. The type of response needed bears on all of the three questions -- Federal/State roles, appropriate authority, and who will be liable. An initial response action can be limited to investigating the site to evaluate the extent and severity of the contamination problem. Should a site pose an immediate public health threat, corrective actions can be taken such as providing a temporary, alternative source of drinking water. Eventually, more permanent solutions may have to be considered, including the establishment of long-term capacity to treat the contaminated water as it is drawn for actual use. In this regard, aquifer restoration will be a very costly, if not an impracticable, type of response when contamination is widespread.

SECTION 2: EPA's PROPOSED POSITION

EPA's response strategy will be to address the problem of ground-water contamination on a number of fronts. The Agency will exercise its own authorities and will also encourage and assist State efforts to remove imminent public health threats posed by pesticides in drinking water. Specifically, the Agency proposes the following policies:

1. Where a pesticide has reached unacceptable levels in ground water, strong actions must be taken to stop further

contamination. These actions can range from enforcement actions to modification of the way a pesticide is managed, including geographic restrictions on the pesticide's use.

An essential part of any response action is eliminating the threat of further contamination of ground water. As discussed in the prevention section, the capacity to respond to reports of ground-water contamination must be developed. When a pesticide is initially detected in ground water, a response should include increased monitoring as well as site-specific determinations as to the extent, source and circumstances of the contamination. Enforcement actions should be taken to prevent further incidents where contamination is found to be a result of misuse. On the other hand, where contamination is the result of approved use of a pesticide, modifications in EPA's or a State's management of the pesticide must occur to minimize the likelihood of further contamination. When a pesticide level has reached or exceeded an MCL or other reference point as a result of normal agricultural use, a more aggressive stance needs to be taken, including the possibility of prohibiting further use of the pesticide in the affected areas.

When the State lacks a management plan to respond to incidents of contamination, EPA will have to decide whether to allow continued use of a pesticide in an affected area. Because the Agency has limited capacity to make site-specific decisions, its choices would most likely be made at a more aggregated level, such as a county or perhaps even an entire State. In this event, infrequent occurrences of contamination in an area may not be sufficient for EPA to undertake county-wide or State-wide cancellation of a pesticide's use. On the other hand, when repeated incidents clearly point to a ground-water threat from a registered use in an area, EPA would have to consider cancelling the use of the pesticide in an entire county or State. This situation underscores the benefits of a State management plan in which area use decisions can be tailored to local circumstances.

2. EPA will encourage a strong State role in responding to contamination. A State's management plan should consider the development of a valid corrective response scheme.

Because a State is more attuned to local conditions, it should have the dominant role in ensuring that corrective actions are taken to address threats to its citizens' health posed by pesticide contamination of ground water. At a minimum, a State needs to take steps to identify and track ground- water contamination in order to determine if current drinking water wells will be affected and to notify users of the potential health risks. By integrating its Federally delegated authorities and resources with its own authorities and resources, a State can provide an effective overall scheme for responding to, and where needed, correcting, public health problems resulting from pesticide contamination of ground waters. In particular, the response scheme should identify the resources and the appropriate corrective actions needed when contamination is found as a result of the approved use of a pesticide.

With respect to funding for response actions, the Agency believes that States should have the lead. In establishing a corrective response capability, a State needs to select from a number of alternative mechanisms. In this regard, a number of States have already adopted or are considering funding mechanisms, such as general State revenues, a State trust fund generated by a tax on pesticide use, or a requirement for users or registrants, jointly or alone, to provide corrective actions.

EPA is also considering the development of a number of assistance measures to indirectly support States in their corrective response efforts. These measures range from site-specific and general technical assistance to providing public information and education. Table II-4 outlines some of these measures.

In summary, a State's corrective response scheme should be a key component of its pesticide management plan. The presence of such a response scheme does not, however, change the primary objective or emphasis in a State management plan from one of prevention. Recognizing that contamination is still a possibility even under the best management efforts, States should develop corrective mechanisms to respond effectively should this possibility become a

Table II-4

Indirect EPA Response Options

Technical Assistance

Site-Specific:

- Review of corrective action plans developed by State/local authorities
- Guidelines for sample analysis and data interpretation
- Development of health advisory notices

General:

- Development of pesticide fact sheet
- Development of treatment technology
- Development of State/local training programs for monitoring, risk assessment, and mitigation methods
- Contingency Plan guidelines
- Information on pesticide contaminations

Public Information/Education Programs

- Telephone hotline for public inquiries
- Pollution insurance information for ground water users
- Low-interest loan information for ground water users
- Press releases on contamination problems/solutions

reality. In the event that a State lacks a corrective response scheme, EPA may consider the option of denying registration, for use in that State, of pesticides that could pose major threats to ground water.

3. EPA will continue to develop and stress enforcement of MCLs. Under the SDWA's emergency powers, EPA will consider issuing orders requiring responsible parties to provide alternative water supplies when levels of pesticides present an imminent and substantial endangerment to public health.

In response to the 1986 amendments to the SDWA, EPA is accelerating the development of MCLs, particularly those for pesticides considered to be potential drinking water contaminants. Once these MCLs are finalized, the States will be able to better assess the quality of drinking water supplied by public water systems. In those cases where a public water system draws on a contaminated ground-water supply, the State must require the system to reduce contamination to acceptable levels before allowing public consumption of the water. A system may treat the water to remove the contamination, blend the water with noncontaminated water to reduce levels in delivered water, or close the well and find an alternative water supply. In some cases, it may not be feasible for a drinking water system to comply with such requirements, and States may need to close the system or provide resources to the system to comply with these requirements. Exemptions to meeting the MCL can be allowed by a State during the time it takes for a system to implement necessary corrective measures, but the system must notify its users that it is providing water with contaminants exceeding MCLs.

Under the 1986 SDWA Amendments, EPA has been given expanded authority to respond to contamination of a public drinking water system or an underground drinking water supply when it may present an imminent and substantial endangerment and when State or local authorities have not acted to protect public health. Under this expanded authority, EPA may issue orders requiring the provision of alternative water supplies by persons who caused or contributed to the endangerment. EPA will consider such action where a public system drawing on pesticide-contaminated ground water poses imminent and substantial endangerment to public health.

4. EPA and the States will place greater emphasis on coordinating FIFRA, SDWA, and CERCLA enforcement activities to identify parties responsible for ground-water contamination as a result of the misuse of pesticides, including illegal disposal or leaks and spills.

Under CERCLA, EPA has the authority to require corrective actions by parties responsible for ground-water contamination as a result of pesticide misuse, including illegal disposal or leaks and spills. The Agency can also recover the costs of cleaning up a site resulting from illegal disposal or leaks and spills. EPA and the States need to take advantage of the CERCLA enforcement authorities by closely coordinating their efforts under FIFRA and the SDWA with those of CERCLA.

5. On a case-by-case basis, EPA may assist States by undertaking CERCLA Fund-financed removal actions to provide alternative drinking water supplies where there is an imminent human health threat.

The Agency may consider on a case-by-case basis providing CERCLA Fund financing for immediate, short-term response actions. Actions under CERCLA's Removal Program can only provide for alternative drinking water and other types of short-term responses to eliminate imminent human health threats. The Agency will seek cost recovery when the contamination is shown to be a result of misuse and a responsible party is identified.

6. The question of who should pay for long-term corrective actions at sites contaminated by the approved use of a pesticide is a legislative question. EPA believes that several aspects of the problem must be considered before a decision can be made.

When contamination of ground water appears to be a result of registered use, and that use was based on sound data and reasonable efforts to predict the potential for contamination, it is not clear who should be considered the responsible party. In this situation, several parties have some involvement, including the user who applied the pesticide, the registrant who brought the pesticide to market, and EPA and state agencies who registered the product. The well owner may even bear some responsibility if he knowingly placed his well in a high-risk setting.

EPA is not in the position to make liability decisions. This question is one to be resolved by Congress or State legislatures. When contamination is a result of use in accordance with the label, all the parties described above could be considered to have some responsibility. Liability in this situation, perhaps, should be limited to mitigating imminent public health threats with provisions for alternative drinking water or point-of-use water treatment.

Table II-5

Pesticides In Ground Water
EPA's Response Strategy

EPA	STATES	LEGISLATION (FEDERAL/STATE)
Registration modification to prevent further area contamination	Modification of pesticide management plan to prevent further area contamination	
Indirect responses of technical assistance to States and public education efforts	Corrective action scheme as part of pesticide management plan; Decision on funding source for responses to imminent health threats resulting from ground water contaminated by registered pesticide use	
Case-by-case assistance to States, under CERCLA Removal Program, to address imminent public health threats primarily by providing alternative water supplies		Need to establish how response to contamination from approved pesticide use will be funded
Better coordination of enforcement activities under FIFRA, RCRA, SDWA, and CERCLA to identify parties responsible for contamination resulting from misuse including illegal disposal or leaks and spills	Better coordination of enforcement activities under FIFRA, RCRA, SDWA, and CERCLA to identify responsible parties for contamination resulting from misuse including illegal disposal or leaks and spills	

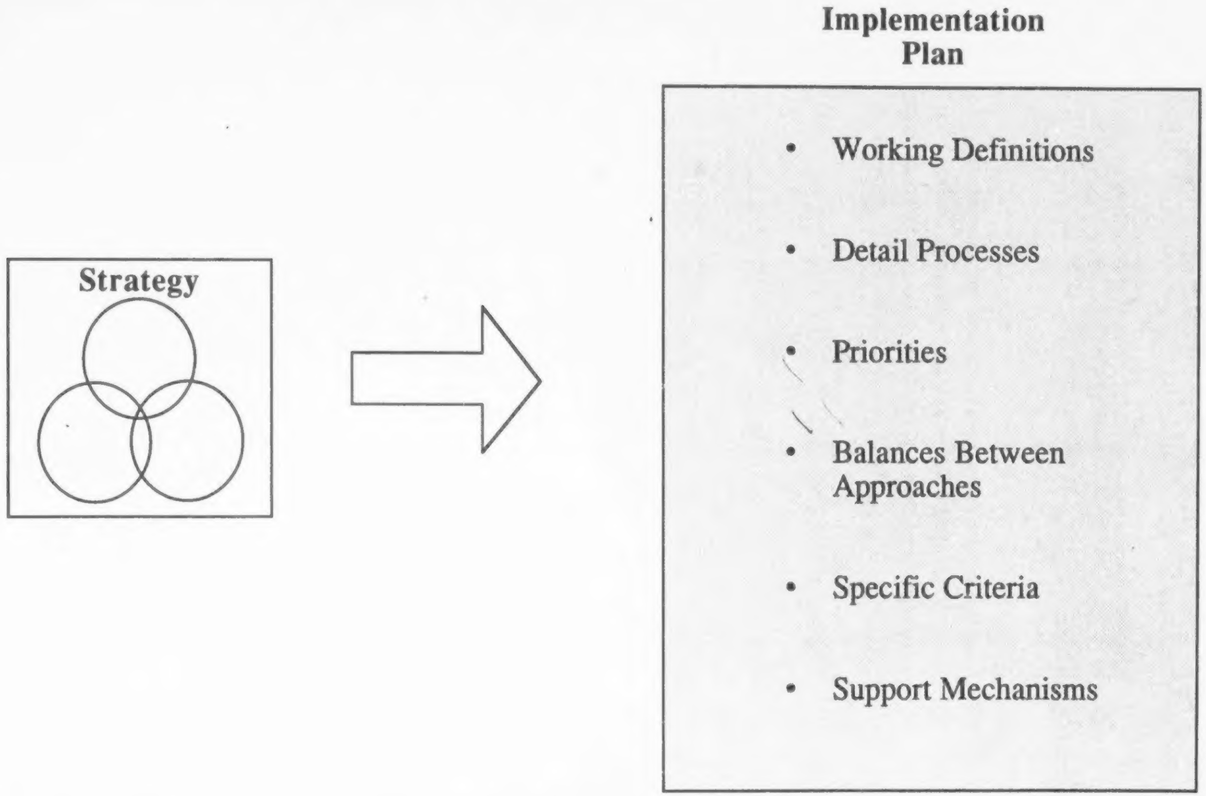
PART III

IMPLEMENTATION ISSUES

The purpose of this third and final part of the document is to present a number of implementation issues raised by the Agency's proposed strategy (Figure III-1). The Agency plans to address some of these issues in its final strategy. A proposed EPA position on several of these issues, however, will have to await the development of future regulatory proposals for specific pesticides in ground water concerns. The Agency is seeking public comment on all of these issues at this time.

Figure III-1

Implementation Issues



Strategy

Implementation Plan

- Working Definitions
- Detail Processes
- Priorities
- Balances Between Approaches
- Specific Criteria
- Support Mechanisms

CHAPTER 1

IMPLEMENTATION - ENVIRONMENTAL GOAL

EPA's goal is to protect the ground-water resource with the focus on preventing unacceptable contamination of current or potential drinking water supplies or ground waters of ecological importance. Protection efforts will be differentiated based on the use and value of different ground waters. Additional protective measures, beyond baseline protection, may be required to provide further assurances that certain "high priority ground waters" are not threatened by unacceptable contamination.

Two key implementation issues underlying EPA's goal are: 1) the definition of potential drinking water; and 2) the definition of high-priority ground water (Figure III-2).

EPA's Ground-Water Protection Strategy (GWPS) defines three basic classes of ground water:

- **Class I: Special Ground Waters** are those that both are highly vulnerable to contamination because of the hydrological characteristics of the areas under which they occur and are characterized by either of the following two factors:
  a) Irreplaceable, in that no reasonable alternative source of drinking water is available to substantial populations; or
  b) Ecologically vital, in that the aquifer provides the base flow for a particularly sensitive ecological system that, if polluted, would destroy a unique habitat.
- **Class II: Current and Potential Sources of Drinking Water and Waters Having Other Beneficial Uses** are all other ground waters that are currently used or are potentially available for drinking water or other beneficial use.
- **Class III: Ground Waters not Considered Potential Sources of Drinking Water and of Limited Beneficial Use** are ground waters that are heavily saline, with Total Dissolved Solids (TDS) levels over 10,000 mg/l, or are otherwise contaminated beyond levels that allow cleanup using methods reasonably employed in public water system treatment. These ground waters also must not migrate to Class I or II ground waters or have a discharge to surface water that could cause degradation.

Figure III-2

Key Implementation Issues for EPA's Environmental Goal

1. Definition and Process for Identifying Potential Drinking Water

2. Definition and Process for Identifying "High Priority Ground Water"

In 1986, the Agency issued draft Guidelines for classifying ground water that further define the classes, concepts, and key terms in the GWPS and describe procedures and information needs for classifying ground water on a site-by-site basis. The Guidelines are now being revised to reflect comments received and are expected to be issued in final form in 1988. The Agency intends to develop methods and procedures that are appropriate for area-wide or anticipatory classification within the next year that can be used for sources, such as pesticides, that are not suited to site-by-site classification.

More than half of the States are now developing and implementing area-wide anticipatory classification systems of their own. In addition to State classification systems, most States are expected to implement the new Wellhead Protection Program under the 1986 amendments to the Safe Drinking Water Act. In this program, States will delineate protection areas around public water system wells and develop and implement management plans for controlling potential sources of contamination (including pesticides).

For the pesticide strategy, EPA hopes to be able to build upon the foundation in the EPA Ground-Water Protection Strategy and draft Guidelines, State ground-water protection strategies and anticipatory classification systems, and the Wellhead Protection Program as a means for determining where baseline and additional protection measures should apply.

1. Definitions and Processes for Identifying Potential Drinking Water

In some major farming areas of the country, ground water may be found very near the surface and thus be easily subject to contamination by agricultural chemicals. Such ground water could have inherent potential as a drinking water source, i.e., low salinity and sufficient yield. However, some of this water would have little, if any, potential as a source of drinking water because of its remoteness from human dwellings or the availability of preferred, alternative sources, including deeper aquifers or surface water systems. As stated in Part II, the proposed goal of this strategy is to protect ground water that is a potential, as well as current, drinking water source. Concerns have been raised that major farming dislocations could occur in some agricultural States if remote shallow aquifers with low potential as drinking water are protected in the same manner as other potential drinking water sources. Conversely, concern has also been raised that other ground waters classified as potential drinking water should receive additional protection because they are in areas of rapid population growth where demand for drinking water is expected to escalate rapidly.

Factors other than inherent drinking water potential might have to be considered when designating protected ground waters. A State may prefer to classify certain ground water in some areas as a low drinking water source because of its location in what are primarily cropping areas with no current or projected drinking water wells within a specified distance. In effect, such an approach would ease the stringency of prevention measures for certain agricultural areas with low-potential sources of future drinking water so as to continue the economic benefit of agricultural production. On the other hand, a State may want to be more protective of certain potential drinking water where rapid population growth is expected to create a high demand for drinking water in the near future. Thus, for agricultural areas, where much of the ground water will be classified as potential drinking water, the Agency is seeking comment on how to deal with the broad range of circumstances that may occur.

The Agency is seeking comments on the following specific questions:

- How serious are both of these concerns?
- How can these concerns be dealt with under the classification guidelines?
- Should subclasses be established for higher or lower levels of protection for certain high or low potential drinking waters? What should the criteria be?
- Should EPA establish criteria and/or procedures for the States to make classification decisions for agricultural areas?
- Should the criteria and/or procedures be mandatory?
- What action should EPA take if a State chooses not to use a classification scheme?

2. What definition and process should be used to identify "high priority ground waters"?

EPA's goal is to provide differential protection to ground water based on its use and value. Specific attention will be given to preventing unacceptable contamination of those waters that are a current or potential source of drinking water (i.e., Class II). Under this strategy, special attention, including where necessary, additional protection measures, will be given to certain "high priority ground waters." A key issue in the implementation of this differential approach is the definition, and the process, for identifying "high priority ground waters."

One possible means of identifying "high priority ground waters" is to use the Agency's draft Guidelines for site-specific classification of ground waters. These guidelines identify "special ground waters" that are to be afforded the highest level of protection from point source contamination. These "special ground waters" are highly vulnerable to contamination and are either (1) an irreplaceable drinking water source for a substantial population or (2) ecologically-vital to unique habitats or endangered species.

Another possible option is to add to those areas with Class I ground waters, Wellhead Protection Areas (WHPAs) as the basis for defining "high priority ground waters." The 1986 SDWA amendments established the Well Head Protection (WHP) Program, which provides EPA with the authority to grant resources to a State to establish Wellhead Protection Areas (WHPA) for each public drinking water well. A WHPA is defined as the area around a public well that can impact the quality of ground water drawn by the well. Based upon Federal guidance and assistance, the States must develop and implement necessary measures to protect the water supply within WHPAs.

Another possibility is to apply the designation of "high priority ground waters" to specific areas around all drinking water wells regardless of whether they are public or private wells. Under this option, WHPAs would be used for public wells, and for private wells, a "buffer zone" or "well setback" of a specified size would be used. The advantage of this option is that it would allow for additional protection for water supplies, including private wells that are likely to be at higher risk than public wells due to their location, depth, or construction.

With regard to this second implementation issue, the Agency is soliciting comments on the following questions:

- How should the Agency define "high priority ground waters" for protection measures beyond those of baseline efforts? Should Well Head Protection Areas be included along with Class I areas?
- Should the definition include buffer zones around private wells?
- Should the States be responsible for identifying these areas using EPA criteria or their own criteria?
- Should the identification and extra protection for "high priority ground waters" be a State prerogative?
- What actions should EPA take in the event that a State is unwilling or unable to identify these areas?

CHAPTER 2
IMPLEMENTATION - PREVENTION

An important component of EPA's prevention program is a coordinated Federal-State differential management approach in which the States will take the lead in making local pesticide use decisions based on local ground-water use, value, and vulnerability. The role of EPA in this management scheme will be to provide oversight, develop standards, and provide assistance to States in developing their pesticide management plans. As part of its management plan, a State will assess where there is a potential for ground-water contamination by pesticides and will implement control measures necessary to prevent or reduce the sources of such contamination. The State's pesticide management plan will also be based on meeting EPA's environmental goal of protecting the ground-water resources with specific attention given to preventing unacceptable contamination of current and potential drinking water or ground waters of ecological importance. MCLs or other EPA-designated protection criteria will be used as the points of reference for helping to determine unacceptable contamination.

Another key component of EPA's prevention program is the establishment of effective programs for anticipatory monitoring and data analysis. To meet this need, the Agency or a State, under its management plan, will establish an "early-warning approach" in response to reports of ground-water contamination. After a pesticide is detected in ground water, the Agency or a State will apply increasingly stringent measures as the pesticide is detected at higher levels and with greater frequency.

Implementation of EPA's strategic approach for preventing ground-water contamination raises a complex web of issues. To simplify, we can group these issues into six categories: (1) generic national control measures; (2) barriers to a differential approach; (3) State management plans - criteria, EPA oversight/support and use; (4) support of user decisionmaking; (5) research and development priorities; and (6) monitoring/early-warning system - mechanism and criteria (Figure III-3). The following is a discussion of these

Figure III-3

Key Implementation Issues for EPA's Prevention Program

1. Generic National Control Measures
2. Barriers to Implementing a Differential Approach
3. State Management Plans - Criteria; EPA Oversight; and Support
4. Support of User Decision-making
5. Research and Development Priorities
6. Monitoring/Early-warning System - Mechanism and Criteria

issues. At this stage in the development of its pesticide strategy, EPA is looking for specific comments on these and other implementation issues before establishing its final strategy.

1. Generic National Control Measures

For pesticides that pose a widespread and serious threat to ground water, the Agency will continue to take national control measures, such as cancellations or suspensions, to protect the ground-water resource. The Agency will also continue to develop generic preventive measures for mitigating ground-water contamination as a result of agricultural practices. With respect to this latter area, the Agency has initiated rulemaking to restrict the use of ground-water contaminating pesticides to certified applicators and has initiated a generic labeling requirement for chemigation. In addition, EPA has initiated a project to examine how various agricultural practices contribute to ground-water contamination.

Some of the questions which are raised are:

- What agricultural practices can be regulated effectively through generic national regulations? How should these practices be regulated? Through labeling?
- What types of disposal measures can be addressed at the national level? (FIFRA or RCRA?)
- How should the States and USDA be involved in the development of national control measures?

2. Barriers to Implementation of a Differential Approach

In the past, EPA has taken a uniform national approach in making its pesticide management decisions. Only recently has the Agency begun to address concerns, such as endangered species, which require a more localized management approach. Similar to the problem of protecting endangered species, the pesticides in ground water concern will require a differential management approach. However, there are a number of important differences which make the management of the ground-water problem more difficult to implement than the endangered species protection efforts. Whereas endangered species protection requirements are primarily limited to geographically defined usage bans, ground-water protection measures will include both usage bans and use modifications. Without extensive State involvement, a pesticide user would be responsible for complying both with minimum county or State-wide measures and with special, more stringent measures for site-specific high-vulnerability or high-risk situations (e.g., close proximity to drinking water wells). The user must determine if his pesticide application site falls into this situation.

Before developing its final differential management approach, EPA is seeking comments on the following implementation questions:

- What types of control measures should EPA consider for differential prevention based on local conditions? Should EPA consider such measures as changes in the rate, timing, and method of application or other farming practices that could influence pesticide movement to ground water? Should the user be required to determine the applicability of "measures" based on site-specific conditions? What types of measures should be considered as special site-specific requirements?
- What are the possible labeling approaches for minimum county- or State-wide prevention measures? How should information be provided to the user to determine applicability of additional special measures to his usage area - through labeling, supplemental labeling, and/or training?
- How can a county-by-county differential approach be enforced? How can additional special measures be enforced? What are the barriers? How can they be overcome? Will users understand and cooperate with a differential approach?

2. State Management Plans - Criteria, EPA Oversight, and Support

The variability of the ground-water resource dictates that the States must play a dominant role in managing pesticide use within their boundaries. Through the development of State-specific management plans, the States can tailor prevention measures to their local conditions. EPA will take the State management plan into consideration in making its pesticide registration decisions. In fact, EPA may cancel a pesticide use because of ground-water concerns in those States that lack an adequate management plan.

Numerous implementation issues are associated with such a Federal/State management effort, including:

- What criteria should EPA use to determine the adequacy of a State management plan? Should EPA review specific State decisions on classifying ground waters, determining prevention measures, or conducting monitoring? Or, should EPA limit its review to a State's general capability by assessing such factors as legislative authority, committed resources, political barriers, technical expertise, and administrative capability? Or, should EPA review the actual plan?

- Should EPA develop specific requirements, or should only guidelines be established for the States to follow in developing their management plans? What basic types of criteria should be developed: vulnerability classification; use and value classifications (including the definition of "high-priority ground water"); or prevention measures for specific ground water conditions? Should State management plans focus on implementing EPA requirements at a higher level of resolution (i.e., sub-county instead of county level)? To what degree should a State have the flexibility to develop alternative measures, including nonregulatory approaches such as user education and training? Under what conditions would the State have maximum flexibility?

- What actions should EPA take when a State's management plan is inadequate or nonexistent? What types of monitoring data would indicate that an existing State management plan is inadequate? What other factors should be considered?

- How should pesticide labeling be used to reflect Federal/State protective measures? Is supplemental labeling or user training the best way to communicate detailed local requirements? What other alternatives are available?

- What level of resources is needed by a State to develop management plans? Are most States currently funding or considering funding pesticide management programs to protect ground water?

- How can a State coordinate the development of a management plan among its various agencies? How can the Federal government stimulate coordination within a State and among several States when contamination crosses State borders?

3. Support of User Decisionmaking

The user is in the unique position of directly controlling the use of a pesticide in the field. The proper use of a pesticide will depend largely on the user's understanding and ability to carry out directions which are specified on the label or provided by other means. Instructions that clearly dictate exactly where a pesticide can and cannot be used, based on familiar geographic landmarks or boundaries, are the most easily implemented requirements, particularly if a map is provided.

However, this level of detail is not feasible on a national scale. As a consequence, the user may have to assess the applicability of certain prevention measures based on a number of site-specific conditions, including the proximity of wells, the depth to ground water, or the type of soil at the site of application. These decisions may sometimes be difficult for users to make, but they are critical for an effective ground-water protection program. As part of its strategy, EPA proposes to provide better technical information to users for making these types of decisions. Some of the questions which are associated with meeting this objective include:

- How can the Federal Government (e.g., EPA, USDA) and the States effectively transmit information to users? Are there ways to eliminate or reduce any liability concerns?
- How can certification and training programs assist the user in making decisions that would affect ground water in his area?
- How can registrants assist the user with regard to proper use of a pesticide? Should EPA and the States require registrants to provide technical assistance to users?

4. Research and Development Priorities

Recognizing that research is an essential element of EPA's efforts to protect ground water, the Agency asked its Science Advisory Board (SAB) on July 10, 1984, to review the Agency's ground-water research program. An executive committee of the SAB summarized the current status of ground-water research activities and presented a number of recommendations for increased attention as well as new initiatives for research. Some of the SAB's recommendations include options pertaining to agricultural chemicals in ground water. Since the issuance of the SAB's report, EPA's Office of Research and Development has initiated a number of ground-water research program reviews to explore ground-water research priorities and to develop a more coordinated program within the Agency, as well as with other Federal and State agencies.

The Agency would like to build on the results of the SAB's report and the Agency's efforts to improve its ground-water research programs by seeking comments on the following issues:

- **Monitoring:** What steps should EPA take to enhance the development of ground-water sampling and analytical methods? How can the development of these techniques be coordinated with USGS? What type of quality assurance/quality control procedures are needed? How can EPA determine the effectiveness of State monitoring capabilities?
- **Fate and Transport:** What types of research should the Agency conduct/sponsor to predict the fate and transport of pesticides in ground water? How effective are current ground-water models in evaluating pesticide behavior in ground water due to physical-chemical processes? How can EPA improve its program of field evaluation of prediction techniques?
- **Risk Assessment:** What types of research studies would best enable the Agency to assess potential risk from pesticides in ground water? Should the Agency develop risk scenarios for populations dependent on public versus private water supplies?
- **Technology Transfer and Technical Assistance:** How can the Agency coordinate the transfer of research data within EPA and with other Federal and State agencies? How can the Federal government and the States get information to the users? Is there a need for a national training center?
- **Agricultural Practices:** What types of research on agricultural practices are needed? Should this type of research be conducted by EPA, USDA, or registrants?
- **Disposal and Leaks and Spills Technology:** What types of research are needed to improve pesticide disposal technology? Who should fund it? Is research needed to improve containment practices for preventing leaks and spills of pesticides? If so, what types of methods should be examined?

5. Monitoring and Early-Warning System -- Mechanism and Criteria

A key element of the prevention strategy is the development of an anticipatory monitoring system to identify emerging problems and to assess the success of pesticide management plans. A number of implementation questions, however, need to be addressed regarding this element of the strategy, particularly in regard to the concept of an "early warning" or "yellow light/red light" approach.

- Based on monitoring data, when should the Agency or States change the management of a pesticide's use within an area? At what levels and frequency of reported contamination should action be taken?

- Is it necessary first to determine the cause of contamination before changing the management of a pesticide use?

CHAPTER 3
IMPLEMENTATION - RESPONSE

In responding to pesticide contamination of ground water, the Federal Government, States, and local governments must coordinate their actions, with the States taking the lead role. Acting together, they must establish the mechanisms to stop further contamination quickly in an area where pesticide concentrations in ground water have reached unacceptable levels. Under its pesticide management plan, a State can tailor pesticide management more precisely than EPA. However, when a State fails to respond, the Agency will take regulatory action for an entire county or even a State, if necessary, to remove the threat of further contamination.

As a key component of its pesticide management plan, a State should develop a corrective response scheme and determine the best mechanism for supporting corrective actions for contamination resulting from pesticide use in accordance with label directions. Working with the States, EPA will coordinate FIFRA, SDWA, and CERCLA enforcement activities to identify responsible parties who must correct ground-water contamination problems resulting from pesticide misuse. EPA will continue to develop MCLs for pesticides, which the State will use to ensure that public water systems are not supplying drinking water with unacceptable levels of pesticide contamination. On a case-by-case basis, EPA will assist the States through Superfund removal actions. These removal actions will focus largely on providing alternative water supplies or other immediate actions to remove imminent public health threats.

Key implementation questions for the Agency's response strategy include (Figure III-4):

- When would it be appropriate for EPA to consider not registering a pesticide in a State that does not have a corrective action scheme?
- What indirect EPA responses, including technical assistance to the States or national public information and educational efforts (see Table III-1), should be a priority for development?

Figure III-4

Key Implementation Issues for EPA's Response Program

1. Considerations for EPA to Register a Pesticide in a State that Does Not Have a Corrective Action Scheme

2. Indirect EPA Responses that Should Be a Priority for Development

3. What Can Be Done to Facilitate Coordination of Enforcement Activities Under FIFRA, RCRA, SDWA, and CERCLA

4. When Should EPA Consider Assisting a State Under EPA's CERCLA Removal Program, and What Criteria Should Define an Imminent Health Threat

Table III-1

Indirect EPA Response Options

Technical Assistance

Site-Specific:

- Review of corrective action plans developed by State/local authorities
- Guidelines for sample analysis and data interpretation
- Development of health advisory notices

General:

- Development of pesticide fact sheet
- Development of treatment technology
- Development of State/local training programs for monitoring, risk assessment, and mitigation methods
- Contingency Plan guidelines
- Information on pesticide contaminations

Public Information/Education Programs

- Telephone hotline for public inquiries
- Pollution insurance information for ground water users
- Low-interest loan information for ground water users
- Press releases on contamination problems/solutions

- What can be done to facilitate coordination of enforcement activities under FIFRA, RCRA, SDWA, and CERCLA to identify parties responsible for contamination resulting from misuse, such as illegal disposal or leaks and spills?
- When should EPA consider assisting a State under the Agency's CERCLA removal program? What should be the criteria for defining an imminent health threat resulting from pesticide contamination of drinking water?

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